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NOTES AND COMMENTS.

The Importance of Carbon.

The influences and effects of special elements in iron alloys have been so much to the front of late years that one is at times somewhat liable to overlook the fact that, of all the other elements contained in commercial iron, carbon is the one of primary importance. The founder, in particular, often very poorly informed on the metallurgical phases of his work, glibly talks of irons of such and such silicon, manganese, sulphur, etc., as though that were the final and all-important point in the composition. To the metallurgist, however, it is perhaps elementary to state that the importance of these elements is mainly in their influence on the condition of the carbon contained in the alloy. Even in alloy steels this still holds good. Sir Robert Hadfield, in his Presidential address before the Faraday Society recently, laid stress on this matter. "In the matter of alloys of iron with other elements," he said, "the fact should not be lost sight of that carbon still pre-eminently holds a position of supreme importance, for the presence of carbon even in special alloy steels is, with some few exceptions, absolutely necessary. Take as an illustration high-speed tool steel, which has led to such an enormous saving in machine-shop practice, with consequent benefit both as regards quicker and greater output, combined with greater precision of execution. Whilst the carbon present need not be relatively high, yet there must be sufficient carbon present, otherwise the cutting properties of the steel in question would not be attained. The explanation is probably as follows:—In high-speed tool steel of modern composition there is usually about 16 to 20 per cent. of tungsten, 2 to 4 per cent. of chromium, and about 0.70 per cent. of carbon. Before treatment of the steel, the carbon exists in the form of carbide carbon and hardening carbon as defined by Ledebur.

	Per cent.
Hardening carbon	0.18
Carbide carbon	0.56
Total carbon	0.74

"After treatment, and with the nose of the tool in the condition required for mechanical work, we find the carbon content to have been transformed into:—

	Per cent.
Hardening carbon	0.60
Carbide carbon	0.14
Total carbon	0.74

"Therefore, when we talk about the wonderful effect of the addition of elements other than carbon to iron, we must not fail to recognise that many, if not all, the new properties acquired by the steel are due entirely to the marvellous change that the treatment has wrought in the form of the carbon present, that is, its transformation from the soft or carbide carbon into what is believed to be the hardening or hardenite form of carbon. Whilst a similar change occurs by heat treating any low-

carbon steel, that is to say, carbon steel without other modifying elements present, or present in very small percentages only, the chromium and tungsten in high-speed alloy steel maintain, or assist in maintaining, the hardenite present in that form, so that the cutting edge does not lose its hardness even when quite a considerable degree of heat caused by frictional contact is reached, which would entirely soften ordinary carbon steel."

Hadfield's Prize for Carbon Research.

So important does Sir Robert Hadfield regard this question of carbon that he has offered the Hadfield Research Prize of £200 for the best contribution on "The Different Forms and Combinations of Carbon with Iron, including those in Iron Alloys." The prize for competition in Great Britain and the Continent will be dealt with by the Council of the Iron and Steel Institute, 28, Victoria Street, London, S.W., while a similar prize will be awarded in America at the annual meeting of the American Institute of Mining Engineers (of which Sir Robert is an honorary member), to be held in New York in February, 1916, for the best Paper on the subject presented to the Institute before November 1, 1915.

The following suggestions are officially offered by the Institute for the guidance of those who may take part in this research. While it is not desired to define closely the exact lines or scope of the proposed research, as it is advisable to make these as broad as possible, the object in mind may be said to be generally as follows :—

To elaborate and find out the best methods of determining the forms of carbon in steel or iron, including those in iron alloys. A portion of the work would probably be a continuation of the researches which have in the past been carried out by Jullien, Abel, Muller, Ledebur, T. Sterry Hunt, Akerman, Arnold, Stead, E. D. Campbell, Hogg, Parry, Upton, and others.

In a generic way, metallurgists now speak of carbides, sub-carbides, double carbides, special carbides, and other combinations. It is very desirable that these should be accurately defined and understood. It is also desirable to know whether there are other or new forms; if so, can these be separated and their characteristics obtained. It may be interesting to point out that the carbon compounds now definitely known are stated to number over 80,000. In addition to research work upon particular forms of carbide which have not yet been determined, it is also desirable and necessary to determine the state in which the carbon exists. For example, there exists what is termed a "missing form" of carbon, about which little is known or understood. More light is required about this form, as for many years very little has been added to our knowledge on this subject. It would be desirable, for example, to know whether the carbon not accounted for as carbide is "missed" in consequence of its being in so fine a state of division, or whether it is present in some special form or condition.

It may be mentioned as a general statement that when steel is in the austenitic condition it is softer than when transformed to the martensitic formation. In the former, the carbon is considered to be in complete solution; yet steel showing martensitic structure is said to contain its carbon in complete solution also. If it could be shown that the martensitic formation results from the commencement of the falling out of solution of the carbon, this would be of great assistance to all those who are desirous of having increased knowledge in this direction. It is, therefore, desirable to know exactly in what state the carbon exists in the austenitic and martensitic formations.

It is also necessary, if possible, to ascertain the molecular constitution of the carbides. Such a point has been raised by the able American scientist Professor E. D. Campbell, and much important research work has been carried out by him with regard to certain particular combinations or forms of carbide. In other words, is the ordinary carbide Fe_3C, Fe_2C_2, or is it some other combination? If so, what is its nature and molecular constitution?

Steel Output in Great Britain.

The publication of the statistics of the British output of steel ingots, collected by the British Iron Trade Association, serves to draw attention to the rapid increase in the output of basic steel in this country. We have only to go back a period of 12 years to find that the output of basic steel by both the open-hearth and Bessemer processes was somewhere in the neighbourhood of the one-million-ton mark, and 20 years ago the output by the basic process did not average half a million tons a year. The progress of the basic process, especially in the last five or six years, has been very marked, as the following figures show :—

Production of Open Hearth Steel Ingots in the United Kingdom for each of the last six years :—

Year.	Acid. Tons.	Basic. Tons.	Total. Tons.
1913 ..	3,811,382	2,251,793	6,063,175
1912 ..	3,365,570	1,908,087	5,273,657
1911 ..	3,131,118	1,869,354	5,000,472
1910 ..	3,016,830	1,578,536	4,595,366
1909 ..	2,763,158	1,385,250	4,148,408
1908 ..	2,628,840	1,238,263	3,867,103

Production of Bessemer Steel Ingots in the United Kingdom for each of the last six years :—

Year.	Acid. Tons.	Basic. Tons.	Total. Tons.
1913 ..	1,048,772	551,929	1,600,701
1912 ..	980,662	541,825	1,522,487
1911 ..	887,767	573,373	1,461,140
1910 ..	1,138,103	641,012	1,779,115
1909 ..	1,111,042	622,178	1,733,220
1908 ..	906,466	572,073	1,478,539

Disregarding the Bessemer process, which shows a stationary output by both acid and basic processes, we find that, taking open-hearth steel in the six years 1908-1913, the output of acid ingots has increased by roughly 1,200,000 tons as against an increase by the basic process of approximately 1,000,000 tons. The relative increase by the basic process is, of course, very much greater than by the acid, and it is not improbable that the figures of the basic open-hearth process, both actual and relative, will, in a comparatively short period, overtake those of the acid process.

As regards the Bessemer process, the last twenty years has not witnessed any serious expansion. In 1893 the total of Bessemer ingots was 1,493,354 tons (1,230,992 tons acid and 262,362 tons basic), and this rose to 1,910,018 tons (1,316,915 tons acid and 593,103 tons basic) in 1903; but last year's output—acid 1,048,772 tons, basic 551,929 tons, total 1,600,701 tons—shows a decline. These figures, of course, relate to ingots. What the statistics of castings would show it is impossible to say, since there are no figures available for comparison over such a period. The Bessemer process has its own special advantages as compared with the open-hearth process for certain conditions of foundry work, and while it may be less suitable for other conditions and very heavy and large outputs, it is not likely for many years to be discarded by the founder.

Practical Notes on Steel Founding.

By G. A. Blume.

The method of casting steel dates back to 1851 when church bells were cast successfully from crucible steel in Bochum, Germany. By reason of the high cost of this material it could not, however, gain a wide market. The development of the open-hearth and Bessemer processes during 1850 and 1860, whereby larger quantities of steel could be produced at comparatively low cost, constituted the first important stimulus to the steel-casting industry. It was not however until a decade and a half later, in the beginning of 1870, that cast steel was made on a large scale. Between 1860 and 1870 the Bessemer process quickly gained headway, but difficulties were met in getting the steel hot enough for casting purposes, and effective means were not then known whereby the metal could be deoxidised, so that a sound material could be obtained. In the open-hearth process, the control of the bath was more nearly perfect, and the metal could be comparatively easily raised to almost any desired temperature, but even here the trouble of gases and oxidised metal remained. The solution of the problem was attained at the French Ironworks at Terre Noire shortly after 1870, by the addition of deoxidising agents, such as ferro-silicon and manganese, through which the gases in the metal could be kept in a dissolved state instead of separating out during the cooling of the steel. The better understanding of the effects of annealing on the structure of the steel provided a further effective impulse to the use of steel for casting, as the homogeneity and safety of the material was thereby largely increased.

It will thus be seen that steel founding as an industry is still comparatively young. Nevertheless, it has quickly forced its way to the front, and a rapidly increased consumption has naturally brought with it increased production, so that its development now is far more rapid than that of any other branch of metal casting. For machinery construction engineers well appreciate its superiority in respect to tensile strength and elasticity, which allows a considerable reduction in weight; the elasticity of steel, further, makes it possible to test important constructions of this material as a whole instead of using the more or less unreliable test-bar, as any deformation can without danger be corrected. Cast steel is further used very often in place of forgings, often on account of cost, as the casting of a construction in one piece is frequently very much cheaper than the forging of complicated forms such as stern posts of ships, parts for railway-coaches and locomotives, etc. A casting also may be stronger than a forging, if the latter is made by the welding of several separate pieces. The advent of steel castings has made possible developments in engineering which otherwise doubtless never could have been practically worked out.

Moulding for Steel Castings.

By reason of the high temperature of molten steel compared to that of molten cast iron, it is not possible to use the same moulding material for the first-named as for the latter; instead a more refractory material must be employed. It is a well-known fact that among steel founders the moulding material used varies very much, so that almost every foreman has his own idea as to what is best; but as a rule the principal ingredients should be ground quartz mixed with greater or smaller quantities of ganister or similar material, together with a suitable quantity, for instance, 10 per cent., of Dutch or English pure white clay, in order to obtain sufficient plasticity. The proportions of the ingredients however vary, both in different foundries and also in the same works, with different classes of castings, much as the fineness and quality of common moulding sand is varied according to the weight of the castings. Large and heavy castings demand a more refractory material than small and thin ones which cool quickly, or the sand will burn to the casting and the surface be rough. For this reason the proportions of quartz and ganister respectively can vary between 4 : 1 and 1 : 1. It is, of course, only necessary to use the highly refractory mass near to the pattern, while the balance of the mould can be filled with regular moulding sand, old steel sand or similar material.

It is of very great importance that a steel mould be sufficiently porous to let the gases freely pass during the casting operation, and to this end steel moulds are generally dried very carefully and far more thoroughly than is usually in the case of dry-sand moulds for cast iron. It should be mentioned, however, that it is possible to use green-sand moulds even for steel, as for instance, if this is made by the "baby Bessemer" process, and this fact has allowed the use of machine moulding in steel foundries, although the practice can hardly yet be said to be common.

Instead of using clay as a binder for "steel sand," the writer has found glutrin very useful, as it makes a more porous mould, and allows casting in undried moulds, especially if the pouring can be done from small ladles or crucibles. In pouring large quantities from bottom-pouring ladles, however, there is great danger of the stream breaking loose pieces of the weak mould and carrying them with it. With skin-drying, however, it is possible to cast successfully pieces as large as from 5 to 10 tons in weight, though it cannot be denied that this involves an element of uncertainty, so for more important pieces where a clean surface is desired the safest way is to carefully dry the mould.

The drying is best performed in ovens heated with coke or gas, but can also be done right on the casting floor if suitable drying apparatus is used. The use of charcoal laid on thin plates over the moulds is out-of-date, as the drying is never homogeneous, and at the same time is slow and uncertain; the same can be said regarding the moveable coke heating stoves, which are sometimes used even in large foundries, and from which the combustion gases are led through the mould. Heating through warm air or gas-pipes is very much to be preferred, while at the same time being cleaner.

Although, as above stated, the drying must be done very carefully and by an even temperature, it is not in the writer's opinion necessary to dry the mould right through, as was usually done by older foremen. It is better to allow the body of the mould to retain the elasticity of the undried sand, as long as its surface to a depth of a few inches is perfectly dry. If the drying is not even, but the mould is damp at certain spots, then steam will form there during the pouring, causing viciousness in the metal and inviting a multitude of small pinholes, which sometimes are deep, but on the other hand frequently cannot be detected on the surface. The same trouble is very liable to occur in winter time or in damp

weather if the moulds are left standing after drying, so that they have a chance to absorb moisture from the air.

In order to prevent the sand from burning to the steel, and thus obtain a cleaner surface, many steel-founders use some kind of blacking, as for instance, graphite, powdered coke mixed in water, or a salt solution. In the writer's opinion such blackings are of little or no value, and in many foundries the use thereof has been discontinued, and the mould is either left without blacking altogether or only painted with claywash or glutrin.

Regarding the moulding operations, little need be said, as the difference between grey-iron moulding, apart from the materials used, is not very great. As previously mentioned, the moulding is mostly done by hand, at least, in Europe. The proper ramming is of importance, as the effect of the molten steel on the mould is far more powerful than is the case with iron, the steel having a pouring temperature several hundred degrees higher than that of cast iron. A weak part of the mould will, therefore, easily be torn loose by the inrushing stream. Large surfaces as well as corners or weaker parts must therefore be strengthened with nails. All chaplets and irons in the mould must be tinned in order to prevent rusting, which would cause gases and blows.

Steel-Making Processes.

Steel for casting purposes is made by four different processes, namely, in crucibles, open-hearth furnaces, Bessemer converters and electric furnaces. Up to the present times the open-hearth process is the most important, and produces the largest tonnage, although in the last ten years the converter has come much to the front, while also electric-furnace steel is being used for castings. Crucible steel is by reason of its high cost not used very much for castings for general purposes, although for special work and for armaments its use is considered warranted.

Open-hearth furnaces are, as every founder knows, either acid or basic, depending upon the chemical qualities of the furnace lining and the nature of refining which the iron is required to undergo. Opinions differ greatly among steel founders as to which method is to be preferred for cast-steel, the acid or the basic, and the advocates of each usually hold very strongly to their own view. A few words as to the characteristics of each, however, may not be out of place. Since in the acid process neither phosphorus nor sulphur can be removed, the raw material for this process must be of a higher grade; the oxidation of silicon and carbon is slower in the acid process than in the basic, but this brings with it the advantage that the initial temperature of the bath can be kept higher so that the final temperature of the steel usually also is higher, and the metal therefore can better expel the gases or keep them dissolved. By reason of the hotter metal the cooling effect of the deoxidising additions is neutralised, and the acid slag has further no tendency or opportunity to oxidise phosphorus from the slag and bring this back into the bath, as is the case in the basic process. On the whole, it may be said that the acid process for castings is somewhat easier to follow, and the risk of bad results is less.

Consequent on the character of the lining material in a basic furnace and the addition of lime to the bath, phosphorus, and also to a certain extent, sulphur, can be removed, so that thereby a cheaper raw material can be used. Some users of the basic process further claim that shrinkage cracks are not so common with basic steel as with acid, but against these advantages stand the above-mentioned liability of a colder bath and oxidation of phosphorus from the slag, so that in spite of the more or less complete removal of this element in the first place, the final product might contain much more phosphorus than desired. It should be stated here, however, that experience has provided good means to avoid this drawback, and during late years the application of the basic process for castings has gained considerable ground. In the writer's opinion none of the advantages or drawbacks of either are sufficiently great to warrant a decided opinion for or against the one or the other.

In melting steel in open-hearth furnaces for castings the size of the furnace should be determined with some regard to the general weight of the goods to be produced, because the metal cools so rapidly that a large quantity cannot very well be held in a ladle for an unlimited length of time. Therefore, if the average run of the castings is comparatively light, the furnace should be made smaller than for a foundry producing heavy work, taking one or more tons of metal for each piece. For the former a furnace of about 5 tons' capacity is, in the writer's opinion, the maximum size, as even then some 200 taps might have to be made before the floor is all poured, and the steel has to be very hot not to cool in the meantime. For larger work, however, no limit can be set, as this naturally altogether depends upon how heavy the castings are. Some of the very large American open-hearth furnaces have a capacity of up to 50 tons, although probably 10 to 20 tons is the average furnace capacity in most of the steel foundries in Europe.

To cast very heavy and very light work from the same heat is not good practice, as the latter class needs metal of very much higher temperature than does the former, and for this reason it is better in such cases to have two furnaces of different capacity, the one from 4 to 5 tons and the other as large as the weight of the large castings and the total tonnage of the foundry will demand.

The melting operation in the open-hearth is practically the same whether the steel is to be used for castings or for ingots, with the exception that the temperature might have to be higher for the former. To get the metal free from gases so that the castings will be sound, an addition is made to the bath, shortly before tapping, of ferro-silicon in such quantity that the silicon in the cast steel will amount to from 0.20 to 0.40 per cent. If the ferro used contains only 10 to 12 per cent. Si., which is customary in the English iron market, it is important to have the bath hot, because with this low silicon in the alloy a considerable quantity has to be added to bring the total up to the figure mentioned, and thereby the chance of cooling the bath is greater. As, further, part of the silicon is oxidised and goes into the slag, this is liable to become very acid, and will lie as a very tough cover over the bath almost impenetrable to the heat. If then the temperature of the bath is not hot enough before the addition of the ferro, the chance is that it will be impossible to raise it even though the melter fires so that the furnace roof melts. The result will be a cool metal, more or less oxidised, and liable to freeze in the tap-hole of the bottom-pouring ladle.

In the writer's opinion it is preferable to use high-silicon alloys containing from 30 to 50 per cent. or more of silicon. The use of such alloys is also to be recommended, because through them the addition of carbon to the bath is very much less than with the greater quantities of lower alloys, and where it otherwise might be difficult to bring the carbon below 0.15, even 0.10 carbon can be had without trouble. Against the use of higher alloys is put forward the possibility of lack of homogeneity in the steel because the alloy comes partly in powdered form and partly as smaller or larger pieces, and it therefore is almost impossible to know how much will be instantaneously oxidised

by the flame. Some steel-makers therefore prefer to use the lower silicon alloy if the carbon does not need to be so low, and the other only if very soft material is to be made, as for instance for electrical purposes.

Converter or Bessemer steel for castings is generally made in converters of comparatively small capacity, *i.e.*, of from ½ to 1 ton. During late years this method of making cast steel has come into greater use by reason of the changes made in the original Bessemer converters, whereby the blast does not go through the metal but instead works on its surface. The first construction of this kind was brought out by Tropenas, but several other types have since been made, all, however, embodying practically the same principles. Tropenas has two rows of tuyeres in his converter, and uses the upper to burn the carbon monoxide formed. Through the surface blowing of the steel the temperature of the metal is very much higher than with the original bottom-blowing converter, and the application of this method for casting purposes has therefore been made possible. The advantages are several. Among these is that the metal is very hot, so that it can be used with advantage for thin castings; the converters are comparatively small and the process very quick, so that small heats can within short periods be made; and, furthermore, continuous service of the equipment is not needed. For such establisments, therefore, where the tonnage is not large enough to warrant an open-hearth installation, which has to be kept running steadily, the small converter is very suitable. Outside of these advantages, however, very little can, in the writer's opinion, be said for the converter as against the open-hearth. It is claimed by its advocates that the moulds need not be dried, but as mentioned above, this is not absolutely necessary for open-hearth steel for the same class of goods. It is further claimed that the converter castings need not be annealed; this might be the case for thin and small castings, but annealing is not necessary for the open-hearth metal either for such goods if the steel is made soft enough. As to quality, very little difference can be noted between the two kinds of steel if both are made with care.

As drawbacks against the converter practice may be put forward the very great oxidation of the bath which, together with the oxidation in the cupola, often runs as high as 20 per cent; while the repairs of the lining have to be undertaken so often that the repair bill runs very high. It is admitted, at least theoretically, that because the converter does not need to be kept running steadily, its use can be very opportune; but against this experience shows that the first blow after the converter has been cold, gives cool metal and heavy losses through oxidation, so that it is far better to keep the converter running steadily so far as the necessary repairs will allow, and therefore the advantage previously mentioned is somewhat discounted.

As a rule the converter process is more costly than the open-hearth process, partly by reason of the heavy oxidation and the frequent repairs, and also because it is necessary to use pig-iron with higher silicon and manganese. To these considerations also must be added the large coke consumption in the cupola in order to obtain very hot metal. The coke consumed for this purpose will run from 15 to 20 per cent. of the iron charged. Finally, the control is better and surer in the open-hearth, where the melter has the bath more in hand. The first cost of installation is naturally considerably larger for the open-hearth than for the converter, and this, together with the usefulness of the process even for a smaller tonnage, has been the dominant factors in the rapid adoption of the latter. Especially in Germany and still more in the United States has this been the case.

Cleaning of Steel Castings.

The manner and means of cleaning steel castings are very different from the means adopted with iron castings. The comparatively large gates and risers necessary for steel castings, together with the toughness of the material, make the cleaning operation very costly and laborious. In many cases it costs fully as much as the moulding and coremaking. Risers on large pieces generally are removed while the casting is cold and before the annealing, as the metal is then not quite so tough as later. The work is done by hand with hammer and cold-chisel, or by sawing, drilling, shaping or turning in machines. Where compressed air is available the cutting of the risers is often done by air-chisels, especially if the piece is so large and unwieldy that it only with great difficulty can be handled in a machine. With risers of very large diameters the cutting would take too long, and it is then better to use cold-saws mounted on swinging frames. As a rule, the cutting off of gates and risers is more expensive when done in machines, because the hard and crystalline metal and the rough surface, with more or less quartz particles adhering, is very hard on the tools. A better way is to cut the risers and gates while the castings are at a red heat, *i.e.*, just as they are taken from the annealing furnace. The cutting can in such cases be done either by chiselling or hot-sawing with specially-constructed saws. After the cutting, however, more or less of the gates and risers will still remain, and this metal, as well as fins on the castings, have to be removed through chipping or grinding. Frequently the steel castings will lose their shape more or less during the cleaning operations, and have to be straightened before they can be used for the purposes intended.

Annealing.

The object of annealing steel castings is twofold:—

(1) To change the coarse crystalline structure of the metal and thereby increase its strength; (2) to equalise the internal stresses which are consequent on the cooling and shrinking of the metal.

Many steel-makers and even metallurgists, have the idea that the latter is the only object in annealing steel castings, and not seldom that opinion is expressed by the specifications issued for the treatment of the steel, but the first-named purpose of annealing is of equal importance. Annealing is frequently not sufficiently understood by the steel-foundry metallurgist, and this phase of steel manufacture may be therefore somewhat more fully treated.

In America it is claimed that annealing is not at all necessary for all classes of goods, and especially such of lighter weight and cast from converter steel, because the material is sufficiently tough and elastic anyhow, and no internal stresses are to be feared in pieces of comparatively even thickness. Test records, however, even from the manufacture of Tropenas castings, show that unannealed castings, even with very low carbon, are much inferior to annealed ones, the elasticity especially being low, in many tests not more than one-half of that of the annealed casting. That such material, therefore, has not the same resistance to shock is plain, and in that its greatest weakness lies. During a tensile test with a gradual-increasing tearing force, or under a bending test where the bend is slowly increased, even an unannealed steel might give good results, but under the hammer it will crack quickly. For any important purpose where a fracture would cause damage and the possible loads are in any way uncertain, all steel castings, small or large, thin or heavy, simple or complicated, should be annealed.

If the carbon content is comparatively high, say from 0.50 to 0.60 per cent., then the annealing is, of

course, still more necessary, and must often be done before the castings can be cleaned, because even a single hard blow is sometimes sufficient to cause a fracture before the internal stresses are removed by annealing. Unannealed steel castings are always more or less uncertain material, and to use such for a balance wheel, a rotor centre for a dynamo, or similar constructions, would be criminal. The case may be considered different where foundries have specialities, and from experience know when annealing is needed and when it is not; but for the average steel foundry doing work for other manufacturers or of a varying character, the only safe course is to put everything in the annealing furnace.

The appliances used for the annealing vary; some of the older foundries even to-day build charcoal fires around the castings, ignite them, and let them burn out during the night, when the process is considered performed, and for very large pieces where the furnaces are not large enough the charcoal heating is almost the only means which can be used, but otherwise specially-constructed furnaces are common, and the heating is done by oil, coal or gas.

The two previously-named objects of annealing require different temperatures. The internal stresses are removed at a temperature of about 1,100 deg. Fahr., and in the older days of the industry this annealing heat was considered sufficient, but in order to change the structure of the steel from the coarse to a finer crystallisation, the heat must pass the "critical temperature," and reach at least 1,500 to 1,650 deg. Fahr. With furnaces of modern construction no difficulties should be met in reaching even higher temperatures, and as a rule 1,650 to 1,800 deg. Fahr. is considered fair.

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As stated, a heat of 1,800 deg. Fahr. can, as a rule, be reached without fear, but if the steel is hard it is better to fire carefully, especially if the castings are large and need to lie in the furnace for any length of time to get heated through, because it might then occur that decarburisation will take place on the surface from the effect of the flames. A soft skin, $^{1}/_{16}$ in. or $^{1}/_{32}$ in. thick, can then be noticed, and analysis will show this surface to have a carbon considerably lower than the interior of the casting. For castings on which a comparatively hard surface is wanted such occurrences might be fatal. In annealing large pieces of hard steel, such as rolls, the heating should be rather slow, extending from 18 to 24 hours, in order to avoid cracks. Cracks are liable to start from the interior, and cannot, in such cases, be observed before the surface is machined to a considerable depth.

Lloyd's British specifications call for a uniform heating of all the parts of a casting at the same time; this doubtless by reason of the older practice of heating large stems and rudder frames one part at a time, when they were too large to be taken into the furnaces completely. For the change of the structure of the steel this specification is of no importance. It is doubtful, however, if a heating piecemeal has any bad effects through new stresses, any more than the heating done while forging large pieces or making welds on forgings. That many metallurgists consider the removal of internal stresses to be the only object of annealing is indicated by specifications which call for slow cooling in the furnace. If the castings cannot be left to cool in the furnace, it is often recommended to bed them in dry sand or ashes until they are completely cold. However, the danger of stresses through rapid cooling preventing regular changes in temperature is very little, especially with low-carbon steels, unless the castings are very large, of complicated form and of uneven thickness. On the other hand, slow cooling might be more or less harmful, by reason of the steel passing the critical temperature so slowly that the pearlite separation is unduly large. When the steel has been cooled quicker it will bend considerably more than the other, and the structure will be denser. The practice of letting the castings cool slowly serves no purpose, and it is preferable to take them out of the furnace to cool in the air. If special reasons exist why internal stresses can be feared, it is safer to heat such castings a second time, but then only to about 1,000 deg. Fahr. In certain tests on the annealing of steel castings, made by F. Sexton, the bars used were 1¼ in. square, and of the following analysis:—Carbon, 0.38 per cent.; silicon, 0.35 per cent.; manganese, 0.65 per cent.; sulphur, 0.038 per cent.; phosphorus, 0.038 per cent. After the treatment the bars were examined under the microscope and tested. The annealing was carried on as follows:—(1) Heating to fixed temperatures ranging from 1,220 to 1,940 deg. Fahr., and slow cooling in the furnace during 12 hours. (2) Heating to fixed temperatures ranging from 1,200 to 2,265 deg. Fahr., retaining the heat during 4 hours, and then slow cooling during 12 hours. (3) Heating to 1,400, 1,652 and 2,012 deg. Fahr., followed by cooling in the air. (4) Heating to 1,472 deg. Fahr. during quarter of an hour, then cooling in water and reheating to 1,110 deg. Fahr.

Mr. Sexton states that the tests show it to be advantageous for steel castings, at least of a composition such as in the material tested, to be heated to 1,830 deg. Fahr., until the heat has penetrated fully through the casting, and to then be left to cool in the air. For heavy castings the cooling should be hastened by means of blast. After such treatment the steel will attain the greatest possible strength and highest elastic limit, as a consequence of the formation of sorbite crystals.

Stead and Richards have described a similar method for the treatment of "sorbitic steel rails." Tests made by Boyton with steel of 0.55, and even more with that of 1.11 per cent. C., have also shown increased strength and higher elastic limit after quicker cooling. Also other metallurgists have reached similar conclusions as to the advantage of quicker cooling after the annealing, and the writer, therefore, believes the following recommendations can safely be made:—(1) The castings should be heated to 1,650 or 1,830 deg. Fahr. (2) This temperature should only be maintained until the castings are well heated all through. (3) Castings too large to be taken into the furnace full length can well be heated one part at a time, but should then be heated a second time all over to about 930 to 1,110 deg. Fahr. (4) As soon as the castings can be considered heated through, they should be at once taken from the furnace and be left to cool, the smaller in the open air, and the larger in an air current or blast, until 1,110 deg. is reached.

Typical Faults in Steel Castings.

In comparison with cast-iron founding the manufacture of steel castings can well be considered difficult. Many obstacles are met with, the overcoming of which needs wide experience. The chances of failure are also very much greater, and even with the greatest of care and skill the percentage of loss will be heavy and also seemingly faultless castings sometimes will show defects during the machining.

The principal faults of steel castings are:—(1) Short-pouring so that the mould is not completely filled with metal or so that wrinkles and misruns show on the surface of the casting. (2) The breaking off of parts of the mould and the lodging of such dirt on the upper surface. (3) Internal stresses, causing cracks, during cooling of the casting. (4) Gas and air blows. (5) Hollow spots or "pipes," caused by the shrinkage of the metal while passing from the fluid to solid state. (6) Cooling or shrinkage cracks.

The first of the above-named faults is a natural consequence of the high-melting point of the steel, and the difficulty of heating it to a sufficiently high point. It is, therefore, not possible to cast steel very thin in the same way as cast iron, especially if the thin surfaces are large. Smaller castings can, however, be made of a thickness of only $^3/_{32}$ in. or $^1/_8$ in. But to cast large, thin surfaces of steel is very difficult, even if the metal is so hot and seems to run so easy that even the very smallest details will come out perfect. This feature seems to be caused by the way in which the cooling of steel takes place, *i.e.*, quicker than cast iron and over larger parts at the same time. It is, therefore, very important to fill the moulds as quickly as possible. The gates should be large and the taphole in a bottom-pouring ladle ample.

The surface of a steel casting sometimes shows wrinkles or folds of the metal seemingly caused by it not having run freely, and usually by the moulders classified as "shortruns." This fault is probably caused by dampness in the mould, not seldom absorbed after the drying, as the fact that the "wrinkles" more often appear on the thick parts of the casting than on the thinner should indicate that the metal is not at fault.

The breaking loose of parts of the mould is caused by it not having been dried well enough or by large surfaces or sharp corners not having been strengthened sufficiently. The loosened dirt will lodge on the upper surfaces of the casting, and it is, therefore, best to provide ample metal for finishing and to cast downwards the surfaces which are to be machined.

The matter of internal stresses has been discussed above, and if specially-sensitive castings are handled with some care before the annealing, no cracked castings should result from that cause.

Gas-blows are generally a consequence of too low silicon in the bath. In acid metal this is rarely the case, but in basic it might occur that too much of the Si. will go into the slag, so that the remaining will not suffice to hold the gases dissolved; they will then separate out during the cooling of the steel, and the castings will be full of blowholes, lying close to each other. It might happen that the metal is so full of gas that risers and gates will have convex upper surfaces and the volume of the metal increase, instead of shrink; if this is noticed such metal has to be thrown out as it is not fit to be used. Blow-holes can also be caused by the mould not being fully dry. In such cases the holes will be small, of a diameter of $^1/_{32}$ in., close to each other, and have a depth of almost $\frac{1}{4}$ in.; they will lie close to the surface, and will show after the outer skin has come off through the annealing. If the air and gas in the mould cannot escape during the time the metal fills the mould, blow-holes will follow. They will be comparatively large, flat and situated on the highest surfaces in the mould. Such blow-holes stop at a distance under the surface and can, therefore, not be noticed until the casting is being machined. By taking care that the venting of the mould is good, through the use of suitable moulding materials, blow-holes of this nature can be avoided. It is always safe, however, to provide steel castings with ample metal for finishing.

The faults which probably are most difficult to overcome are those mentioned under (5) and (6) above, namely, "pipes" and cracks. The former are caused by the shrinking of the metal while cooling. This begins along the walls of the mould, and from the surfaces proceeds inwards. The decreasing of the volume caused by the shrinkage is counteracted by drawing metal from the parts which still remain fluid, and this action naturally passes from the inner parts towards the outer, so that finally in the centre an empty space, or "pipe," is left. As seen, the pipes must form, unless means are provided to prevent them, as by applying risers or feeding heads on the castings and in such places that the decreases in volume are supplied with metal, whereby the final pipe will lodge in the riser and leave the casting dense. The correct placing and suitable dimensioning of risers and feeding heads is one of the very important demands which the skilled steel founder has to meet. The metal in the risers is so much waste, and it is important that they be made no larger than necessary. To get the pipe to lodge in the riser this must cool last, and it should, therefore, be placed so that the cooling will go in the direction towards the riser and not from it. As a rule, those parts of the casting which are larger than the surrounding ones must be provided with risers, and it should be plain that the thickness of these must be even, so that the metal has no chance to cool in them before in the casting.

Sometimes it is impossible to place ordinary feeding heads on parts where they are needed, and it may then be necessary to add to the thickness of the casting or even provide additions to certain parts to supply metal to draw from, such added additions being machined off later. As an example might be mentioned a roll, where, if the roll is cast on end, the application of a riser on the heaviest or centrepart is not possible. If no feeder is provided pipe will occur in the centre of the heavy part, and the casting will be more or less unsafe. If, in order to overcome the pipe, the upper and smaller end of the roll casting, is extended so as to form a feeding head, the pipe will still occur, because the last cooling will not take place there, but in the heavy centre. It is, therefore, necessary to cast the roll with the same diameter all the way up to the top, and extend it upward to form the required feeder. Many other examples could be mentioned where it might be necessary to make large extensions or changes in the form of the original pattern in order to get the required feeding of the shrinkage, but what has been said should be sufficient to show the importance of care and judgment in the proper feeding of shrinkage.

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The relation between the weight of the feeding head and that of the finished casting also varies considerably, so that it sometimes can be as low as 15 or 20 per cent., but then again it can often run up to 100 per cent., while the average in most steel foundries is rarely much below 50 per cent. It is economical

course, still more necessary, and must often be done before the castings can be cleaned, because even a single hard blow is sometimes sufficient to cause a fracture before the internal stresses are removed by annealing. Unannealed steel castings are always more or less uncertain material, and to use such for a balance wheel, a rotor centre for a dynamo, or similar constructions, would be criminal. The case may be considered different where foundries have specialities, and from experience know when annealing is needed and when it is not; but for the average steel foundry doing work for other manufacturers or of a varying character, the only safe course is to put everything in the annealing furnace.

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to keep the weight of this scrap as low as possible, but the form and construction of the piece will determine how large the risers must be. In arranging for the cooling to proceed towards the riser, the gates must be placed so that the steel will cool last here. The most radical way to gain this result would, of course, be to let the metal enter in the upper part of the mould, but this can rarely be done because the risk of pieces breaking out in the mould then is greater; it is, therefore, customary to cast from the bottom, and in order to avoid the coldest metal coming in the riser, the metal is poured through the gates only until the mould is filled up to the bottom of the riser, and then hot steel is poured directly in this. In placing the gates for very deep moulds it is well to use a few intermediate gates at different levels, so that the steel which is rising in the mould will be livened by hotter metal entering through the higher gates. The use of artificial means, such as Thermit, to keep the metal fluid and hot, the writer does not believe to be anything but half-measures at the best, and it is better to have everything so well provided for that such addition can be avoided.

The last of the above-mentioned common faults in steel castings is cracking, of which there are two distinct classes, viz., that caused only by the contraction of the metal while cooling and that which is consequent on internal shrinking. The contraction of steel castings is usually figured at 1.8 to 2.0 per cent., for which additions have to be made on the patterns. It must be remembered, however, that, like the shrinkage, the contraction is not constant, and can be different even in different parts of the same casting, depending upon the form of the piece as well as upon the elasticity of the mould. The contraction will, for instance, be larger if the casting is uncovered immediately after pouring than if it is left to cool in the covered mould. Contraction cracks will usually appear in thinner parts, and must frequently be remedied through welding.

Cracks caused by the shrinkage of the steel mostly occur in corners, close to ribs, and changes in thickness of the casting, etc., and are often very troublesome. The metal will in such places keep fluid longer than on straight parts, and the feeding will, therefore, go from them, leaving the casting weaker, so that the resistance to contraction stresses is lessened and cracks result. Such cracks sometimes have the character of an extended pipe rather than of a regular crack. To overcome cracks of this kind recourse must be had to the regulation of the cooling, judicious placing of the gates, and the application of strengthening ribs. Some foundrymen try to overcome the difficulty by uncovering the casting as quickly as possible after it is cast, but this can hardly be an effective way, because the cracks occur at the moment the metal passes from the fluid to the solid state, and it is naturally impossible to have the casting uncovered so soon. Only experience can provide the right use of the means available to avoid them, and in this connection only a general idea of how they can be employed can be given. The cooling is regulated by placing a number of nails very close to each other at the points where cracking is feared or by the application there of chilling plates, etc., all in order to hasten the cooling there, and thus make it more even over the whole casting.

In cutting the gates it should be borne in mind that the hot metal must be kept away from the points where the cracks are liable to appear; in casting, for instance, a flange with a horizontal and a vertical part, the gate should be cut on the top, and not on the circumference of the horizontal part, where the cracks naturally would be. Strengthening ribs are cut at right angle with the line on which the cracks are to be feared; they should be thin so that they cool quickly and thus help to resist the strain during the contraction.

In spite of all care it seems sometimes to be impossible to avoid cracking, and the only way then is to change the construction of the piece so that the dangerous points can be avoided.

Strength of Cast Steel.

Steel castings can be made with carbon at almost any figure from 0.10 to 1.50 per cent., and with different characteristics. Open-hearth metal for casting purposes is, however, usually made in three grades of hardness: very soft steel with a tensile strength of about 55,000 lbs. per sq. in., suitable for electrical purposes; medium hard, used for average machine castings, and with a strength of from 62,000 to 72,000 lbs. per sq. in.; and hard steel for parts which must have resistance against wear, etc., and with a strength of from 96,000 to 125,000 lbs. per sq. in.

A very important quality which should be looked for in steel castings is resistance to shock and heavy blows. As a rule the castings are not tested with a view to ascertaining this quality as often as should be the case, so that no figures can here be given to show common results in this respect. In breaking up steel castings it can be noticed, however, that frequently the strength compares favourably with forgings, so that they will stand considerable bending and a good many blows before breaking. Castings, nevertheless, are not suited to indiscriminately replace forgings, although several attempts have been made to make such pieces as crankshafts, shafts for engines and pistons, etc., from castings. The main reason for the superiority of the forged material for such purposes is reliability, as one can never be absolutely certain of the density and freedom from gas-blows and pipes in the case of castings. On the other hand, the castings are much to be preferred for such constructions which cannot be forged in one piece, as, for instance, stern frames for vessels, rudder frames, locomotive driving wheels, etc., where welding otherwise would be involved.

ALUMINIUM IN RAIL STEEL.—Some interesting information as to the effect of aluminium on steel ingots is given in a report by Mr. M. H. Wickhorst, engineer of tests to the Rail Committee of the American Railway Engineering Association. According to the report, ingots treated with aluminium added to the mould are of more even composition throughout than plain Bessemer steel. There is less positive segregation in the interior and upper part of the ingot, but the negative segregation or soft centre in the interior and lower parts of the ingot is about the same. There is a softening or negative segregation in the upper part of the wall of the plain ingot, while in the aluminium-treated ingots the walls are of fairly even composition throughout the height of the ingot. Aluminium-treated ingots have larger and deeper pipes than plain steel, but denser steel around the pipes. Rails of plain steel have a brittle zone in the upper part of the bar as disclosed by the drop test. In the rails of aluminium-treated steel this zone is largely eliminated. Rails of plain steel contain their laminations close to the top end of the bar, while in aluminium-treated rails the interior laminations are found a considerable distance from the top end, varying from about 30 to 45 per cent. of the weight of the ingot. In a transverse test of the base, rails of aluminium-treated steel showed considerably greater transverse strength of the base and sag of the flange before breaking than the rails of plain steel, with 0.61 per cent. carbon and a little greater strength and sag of flange with 0.45 per cent. carbon.

Solid Expansions and Contractions in Cast Iron in Relation to Composition and Thickness.

By Sidney G. Smith.

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It has been demonstrated by Professor Turner, Keep, and others, that grey cast iron expands on the point of and after solidification, and that there are three distinct arrests and well marked expansions occurring at about 1,050 deg., 900 deg., and 730 deg. C.; and that these expansions and arrests correspond with the separation of primary graphite, the phosphorus eutectic, and secondary graphite respectively.

In white iron only one faint expansion arrest is observed, occurring at about 700 deg. C. Now in practice, so far as moulding is concerned, at any rate, no special provision is made for cooling expansions in castings. Precautionary provisions are made for expansions by heating, such as of core barrels, loam plates, etc., and also adequate provision must be made for contraction in the castings and tackle; but cooling expansions must be so infinitesimal that no ill

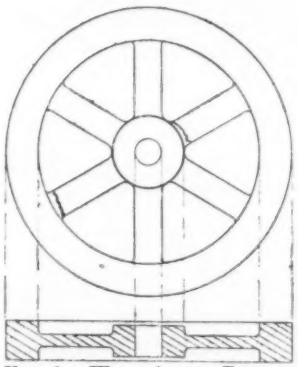


FIG. 1.—WEAK ARMED PULLEY.

effects are observed. But in regard to the design of a casting, cooling expansions may make a vital difference, to which reference will be made later.

Admitting that cooling expansions do occur, it may reasonably be suggested that these expansions vary with the composition of the iron and rate of cooling, seeing that with white iron the expansion is almost imperceptible, and that with grey iron three different expansions occur at different temperatures, corresponding with the separation of carbons. Between a high- and low-carbon and silicon iron, there must be a great difference in these separations, and consequently in the expansions. In a very grey iron corresponding to No. 1, containing 4 per cent. carbon, nearly the whole will be in graphitic form, but in a mottled or white iron, the carbon is chiefly in combined form; hence in the latter less separation takes place, and in the former the greater separation must occur. It is thus reasonable to assume that cooling expansions vary considerably, and are more pronounced in a high-carbon iron than in a low-carbon iron, and also less in a hard grey iron than in a soft iron.

In the foundry no trouble is experienced from cooling expansions, but often much trouble is given by cooling contraction and liquid sinkage and shrinkage. With medium and large, heavy castings, in which the period of solidification is of hours' duration, cooling expansions will have little chance of exerting any influence; with such castings the difficulty is to compensate by means of feeding and large heads, the liquid sinkage that is going on during the solidifying period. For instance, a large hydraulic ram, 20 in. internal dia., 30 ft. long by 2½ in. thick, cast vertically (which is the right method), would require a feeding head 3 ft. long and probably 8 to 10 cwts. of extra

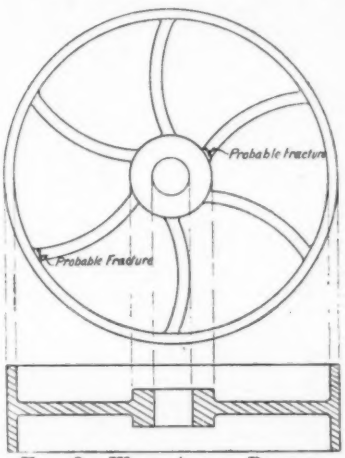


FIG. 2.—WEAK ARMED PULLEY.

iron poured into the feeding head at intervals after casting. The casting would probably take over an hour to solidify, and different parts would solidify at different times, the uppermost part being longest in the liquid state. Now it would be unreasonable to suppose that a casting of these dimensions would commence to expand when the top part of it had become solid, seeing that the expansions are given at different temperature and the casting is cooling at these temperatures at the same time. If it were possible to divide, or sub-divide, the whole length cooling at those temperatures at the same moment, the conclusion arrived at would be that one part of the casting was expanding while another was shrinking and requiring feeding. Large rolls or large, heavy hydraulic pipes are other examples. The same reasoning would apply to any heavy section of vertically-poured mould.

Castings made in Iron Chills.

Many castings, such as small pipe connections, are now made in chills, cores included, and are stripped as soon as the iron becomes solidified. With this

method such castings must be liberated from the chills before the expansion, or expansions, takes place; if that were not done, the chills or their fastenings would break, as there is also an expansion of the chill due to the heat absorbed. On the other hand, it might be assumed that such castings, which are not very thick, when cast in iron moulds have all the carbon in the combined form until the stripping period is over, the metal approximating to white iron. Of course, the separation of the carbon to either the temper, graphite, or some other free form must occur eventually, because the castings are grey and easily machineable, and do not go through any special annealing process.

It may be that with chill-made castings the cooling expansion of the iron, combined with the expansion of the chills, exercises powerful compression on the castings, to which perhaps is due the superiority claimed for them.

Cooling Expansion in Relation to Design.

Reverting to the influence of cooling expansions, if such is to any extent appreciable, it is of vital importance in regard to design, and points unmistakably to the necessity of uniformity in section or thickness. It is clearly possible that with a casting of unequal thickness internal stresses exist, and this applies especially to jacketed cylinders, covers, valves, condensers, bedplates, and many other kinds of castings where walls or divisions are in close proximity, and are of different thicknesses. Great trouble is experienced in these castings with solid contraction in cooling, and to add avoidable cooling expansions to existing trouble increases considerably the difficulty which the foundryman has in producing sound castings free from stresses. For a simple instance, may be taken an armed pulley or wheel of any description, where the boss or hub and the rim are of greater thickness than the arms. (See Figs. 1 and 2.)

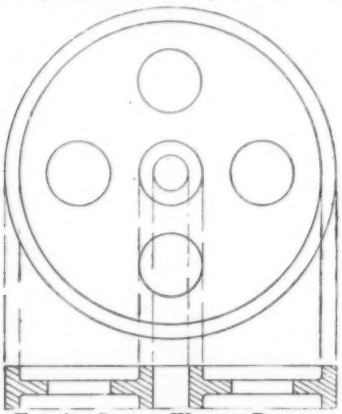


Fig. 3.—Strong Webbed Pulley.

In either of these designs, which are quite common the arms are less in thickness than the hub or rim, and in considering cooling expansions, plus contraction, in the same casting of unequal thickness, it is obvious that stresses are set up. If fracture does not occur when cooling, it may do so at any time under slight provocation, because the arms solidify first, therefore expand and contract first. If the cooling be followed closely, it will be seen that when the temperature arrests and expansions are reached in the arms, which is before such temperatures are reached in the rim or hub, owing to less thickness in the arms, they must expand two ways at least, *i.e.*, into the hub and into the rim. That occurrence alone does not favour a durable casting, but the evil does not end there, for as soon as the expansion temperature is passed, contraction of the arms commences. The rim and hub follow the same laws, but later than the arms, hence the contractions and expansions of different temperatures are acting and reacting in the casting at the same moment.

Now it is only reasonable to suppose that when the iron in a casting of different thicknesses is expanding and contracting in opposition, some influence must be exerted on the molecular or crystalline structure; and it is well known that when fracture does occur it is near the junction of the arm and rim, or the arms, hence the contractions and expansions of different temperatures are acting and reacting in the casting at the same moment.

In practice the method adopted is to bare the thick parts and cover the thin parts, endeavouring to make the rate of cooling more uniform, but it is not always practicable to do so. The temperatures at which occur the volume changes, or expansions, that are more particularly being dealt with now, are passed before any manipulations such as covering or uncovering can be performed. The design should be uniform to produce a stress-free casting, even if to secure this such castings are made in halves, or are cut through the rim or hub. An arm design of cast-iron pulley or wheel is not favourable to a stress-free casting; wheels are far superior if a web or thickness of iron is carried through from the hub to the rim, as in Figs. 3 and 4, corresponding in thickness to the latter. This also applies in many cases to tooth or spur wheels, but the objection is the extra weight of casting involved. Some designs approximate to this by using chamber cores to form and strengthen the arms.

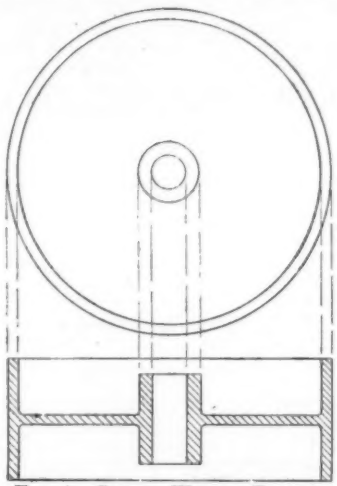


Fig. 4.—Strong Webbed Pulley.

Application of Chills in Loam and Sand Moulds.

It is not now proposed to discuss castings such as chilled rolls, car wheels, pile shoes, metal breakers, etc.; these castings are chilled to produce a hard surface. The judicious application of chills in ordinary moulds to ensure soundness will rather be treated; for the use of chills for such purposes is quite legitimate and beneficial.

Figs. 5 and 6 show respectively a tunnel segment and a large lug. In each of these cases the chill is

placed near a junction, or where there is a thicker body or section of iron than the other part adjoining. It has been previously stated that where thick and thin sections of a casting are in conjunction there will often exist a more or less porous or spongy area in the thick section. Doubtless certain qualities of iron may minimise this sponginess; but it is essentially due to the thinner sections solidifying first and sucking or drawing the iron away from the thick section which has solidified. This action sometimes proceeds beyond the point of porosity and sponginess, leaving what is known as a draw-hole. This is partly due to liquid shrinkage caused probably by the evolution of heat, molecular action and crystalline formation from the liquid to the solid—a phenomenon at present very little understood.

The troubles in question may be prevented by uniformity in section, which involves design, and by feeding, which depends upon the method of moulding. Both of these preventives are often impracticable or inconvenient, and in such cases the trouble must be overcome in some other way. To some extent the end may be attained by making chills of the desired shape and placing them where the porosity or shrinkage occurs. The writer does not contend that the chill makes a thick section solid throughout. The effect of the chill is to assist the thick section to solidify more rapidly by absorbing the heat, thus making the cooling of the thin and thick sections more

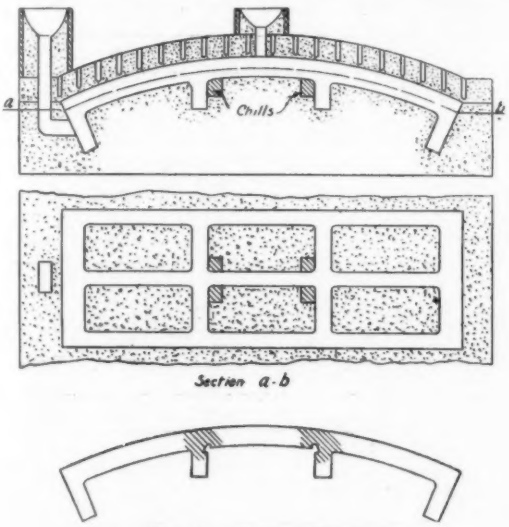


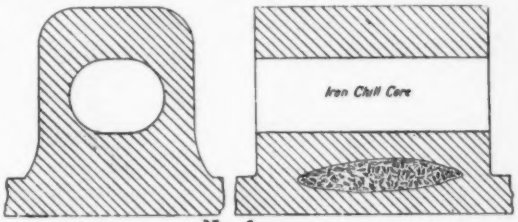
FIG. 5.—TUNNEL SEGMENT.

uniform in rate, and although some porosity may exist in the centre of the thick section, it is more than counteracted by the close-grained iron on the surface next to the chill. Also, when chills are used in this way there is no appearance of draw, crack, or draw-holes upon the surface. The importance of this effect must be obvious.

Regarding hydraulic pressure pipes that are cast horizontally, the slight hardening of the iron in the thick places to which chills are applied is all in favour of the casting, the only difference being a slight increase in combined carbon upon the wall next to the chill. But the use of chills, apart from the aspect just considered, is finding favour for many kinds of castings, the claims put forward by various writers being cleanness, soundness and improved physical test results.

Fig. 5 gives a sectional view of a tunnel segment showing the chills in the moulding box. The lower section shows the possible defects if the chill are not used in heavy-section segments.

Fig. 6 illustrates an instance of extremely bad design, which is by no means imaginary or uncommon, as several of these and others similar have passed through the writer's hands. The section is of a lug cast on the spigot end of a 40-in. pipe, with an oval hole cast in. Sketch No. 1 shows the great difference in thickness of iron around the core. As these castings are rammed, dried and poured vertically, with a dross head the same thickness as the spigot end, the bolt carried upwards as shown in Fig. 7, it will be apparent that it is impracticable to apply a feeder to make absolutely sound or solid the thick section of the lug. Sketch No. 1 (Fig. 6) shows sponginess indicated by



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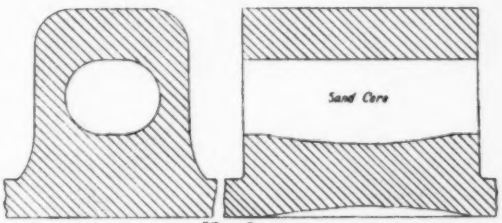

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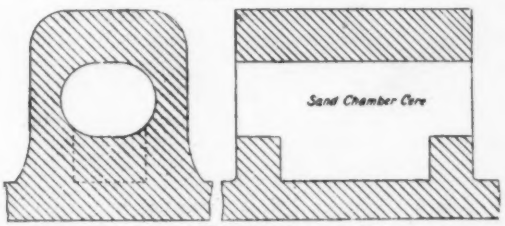


No. 3.

FIG. 6.—INCORRECT (1 AND 2) AND CORRECT (3) DESIGNS FOR HEAVY LUG.

the dotted part, when an iron chill is used instead of a sand core. Although there is good solid iron next to the chill, and in the bore of the pipe, the lug is far from being perfectly solid. Sketch No. 2 shows the result when a sand core is used. It will be noticed that the metal has been drawn away by the thin section of the casting, leaving an irregular aperture next to the main or body core in the bore, and also next to the oval lug core in the thick part of the lug, which is most unsatisfactory from all points of view. Sketch No. 3 shows the form of core the writer suggests, *i.e.*, a chamber core, which gives equality of thickness and allows the lug to be perfectly solid. Although the lug would be less in weight it would be decidedly stronger in any part than the other designs.

Unfortunately, foundrymen are not often permitted to make suggestions, and if by rare courage they have the temerity to do so, they are generally told to work to the drawing. In such cases the resourcefulness of the foundryman to produce a satisfactory casting is severely taxed.

Suitable Mixtures of Iron for Various Kinds of Castings.

The following are mixtures of iron used in some marine foundries on the North-East Coast:—

Cylinders:—

Per cent.
50 Selected scrap, or remelted pig.
20 Scotch pig.
30 No. 3 G.M.B. Cleveland.

Condensers:—

Per cent.
50 Selected scrap.
15 Hematite pig.
15 Scotch pig.
20 No. 3 G.M.B. Cleveland.

Bed Plates, Pumps, and other Castings.

Per cent.
50 scrap.
50 No. 3 G.M.B. Cleveland.

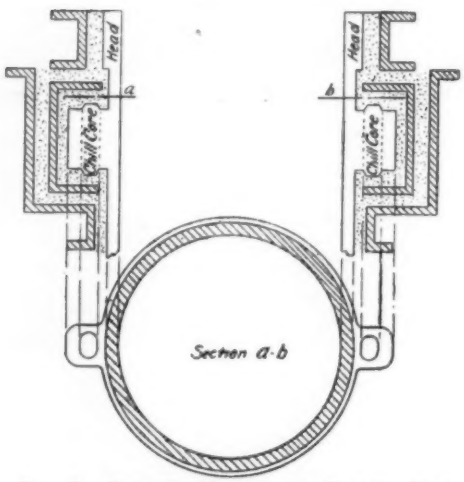


FIG. 7.—SHOWING METHOD OF CASTING PIPE WITH LUG SHOWN IN FIG. 6.

Ingot Moulds.

The following analysis of hematite iron was given the writer, and lasted 62 heats:—

Combined Carbon.	Silicon.	Manganese.	Phosphorus.	Sulphur.
Per cent. 0.180	Per cent. 0.643	Per cent. 0.533	Per cent. 0.059	Per cent. 0.063

To produce fairly good results from castings requiring different qualities of iron, the writer compiled the following approximate analyses, for which he takes responsibility. At the same time, foundrymen may attach to them what value they may be found to deserve:—

Pipes under ¾ in. thickness require a soft open-grained iron. Approximate Analysis.

Combined. Carbon.	Graphite.	Phosphorus.	Manganese.	Silicon	Sulphur.
Per cent. 0.15	Per cent. 3.20	Per cent. 1.50	Per cent. 0.65	Per cent. 2.30	Per cent. 0.04

Pipes over ¾ in. thickness require a medium soft iron with good deflection and transverse strength.

Combined Carbon.	Graphite.	Phosphorus.	Manganese.	Silicon.	Sulphur.
Per cent. 0.30	Per cent. 3.00	Per cent. 1.25	Per cent. 0.70	Per cent. 2.00	Per cent. 0.05

Columns and Stanchions require iron strong in compression.

Combined Carbon.	Graphite.	Phosphorus.	Manganese.	Silicon.	Sulphur.
0.50	2.75	1.50	0.80	1.25	0.10

Large Brackets and Girders require iron strong in transverse and tensile strength.

Combined Carbon	Graphite.	Phosphorus.	Manganese.	Silicon.	Sulphur.
0.70	2.60	1.00	0.90	1.40	0.90

Hydraulic Ram and Cylinders, Steam and Gas Cylinders require a close-grained, dense, strong iron.

Combined Carbon.	Graphite.	Phosphorus.	Manganese.	Silicon.	Sulphur.
0.70	2.55	1.00	0.80	1.30	0.10

Spur and Gear Wheels require iron strong in compression, transverse and tensile strength.

Combined Carbon.	Graphite.	Phosphorus.	Manganese.	Silicon.	Sulphur.
0.80	2.45	1.00	1.00	1.20	0.10

Pulleys, Flywheels, etc., require a soft, tough iron.

Combined Carbon.	Graphite.	Phosphorus.	Manganese	Silicon.	Sulphur.
0.15	3.20	1.00	1.00	2.50	0.03

*Tests and analyses of cold-blast charcoal pig-irons used for chilled rolls.**

Analyses.						Tests.	
Combined carbon.	Graphite.	Silicon.	Manganese.	Phosphorus.	Sulphur.	Tensile in tons per sq. inch.	Transverse in cwts. Test bar 3 ft. by 2″×1″.
0.64	2.21	1.07	0.456	0.261	0.10	16.8	41.6
—	—	1.37	0.456	0.243	0.11	18.7	42.3
0.95	2.18	1.28	0.395	0.295	0.14	16.2	47.5
0.65	2.30	1.07	0.517	0.321	0.10	—	43.3
1.00	1.90	1.40	0.365	0.234	0.14	—	44.3
0.70	2.32	1.40	0.395	0.227	0.14	19.3	44.3
0.62	2.14	1.47	0.486	0.200	0.13	17.45	41.1
0.60	2.18	1.26	0.471	0.324	0.13	17.6	41.3
0.63	2.21	1.04	0.456	0.277	0.09	—	44.0
0.80	1.90	0.93	0.425	0.277	0.09	—	45.7
0.73	Average of 10 Tests. 2.15		1.23	0.45	0.266	0.12	17.68	43.6

* H. B. Toy, "Proceedings" of Cleveland Institution of Engineers, 1908.

A Green-Sand Core for a Road-Engine Saddle.

By V. Dewhurst.

When first the suggestion was made to produce these castings by green-sand cores, it was greeted with expressions of "Impossible, can't be done." "Too risky, it won't hold together," etc. But nevertheless it has been done, and done well. Moreover, we can do it again, and any similar castings will be similarly made. Also, we are doing a great deal more green-sand core work than we did before, by reason of the success obtained with this one. The average weight of the saddles in question is as this part of the casting fits partly round the boiler, and is not machined, but chipped to fit, if necessary.

The pattern (Fig. 6) which shows core prints or seats, is made in halves, through line D D (Figs. 2 and 3). It is moulded one half in the bottom box or flask, and the other half in the top flask. We are not, however, dealing with the actual moulding of the pattern, but its core. The core box (Fig. 7) is also made in halves, split the same way as the pattern, and if the view Fig. 7 is examined, it will be seen

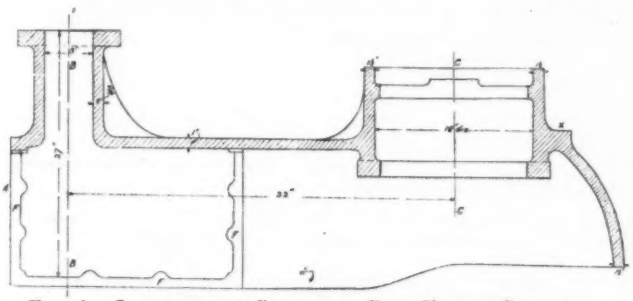


FIG. 1.—LONGITUDINAL SECTION OF ROAD-ENGINE SADDLE.

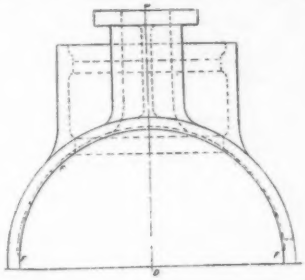


FIG. 3.—VIEW AT A.

9½ cwts. Some, of course, are smaller, varying in size and weight according to design, class and weight of engine. To make castings of this size and weight in this manner seems to many moulders at first thought impossible; yet it is quite easy, simple and effective, and when once done, one wonders why he has been trudging in the dry-sand groove in the same way so long.

An examination of Figs. 1 to 5 will give a good idea of the castings in question. These saddle castings are mounted on the top of the boiler, in front of the engine; the pipe part with flange carrying the chimney, and the part C C (Fig. 1), being the chamber for the swivel working the two front wheels. This part of the casting is the actual front of the engine; the small boss part marked X (Fig. 1), carries the lamp. The distance from centre of chimney to centre of swivel chamber is 32 in., the greatest depth is 27 in. and the general thickness 1 in. to 1½ in. The small facings marked F (Figs. 1, 2 and 3), and the strips between same are required to be accurately moulded,

that it contains all the lines shown in the interior of the casting, as in Fig. 1, together with the extended parts to fill the core prints or seats.

The core box was originally made for dry-sand cores, so to convert it for green-sand, the side marked X X was taken off, as in Fig. 7. Fig. 8 is the core iron, on which depends the success or otherwise of the core being made. The secret of success in all green-sand core work lies in the iron, its formation and adaptability to the particular core

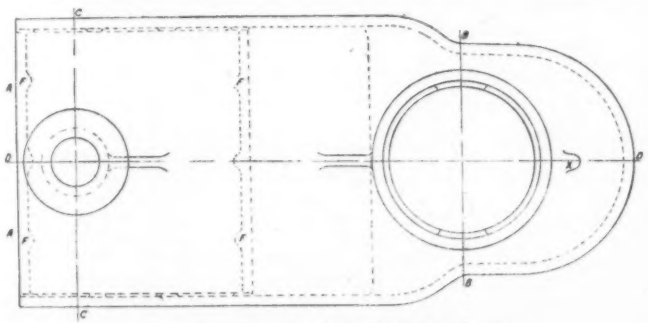


FIG. 2.—PLAN OF ROAD-ENGINE SADDLE.

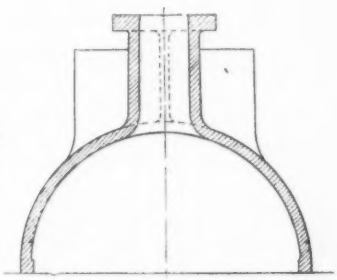


FIG. 4.—SECTION ON C. C.

under manipulation. It is here that the moulder must insist upon the core iron being made in every particular to suit the core. There is no necessity to make a full pattern for this iron. The two main centre sides carrying the half-moons would be 2 in. thick, one deeper than the other, according to box; a dozen quarter-moons, in sizes according to core box, are bedded in on each side of the centre ribs. A full-size board is made correct depth and length, with centres for centre ribs marked on and made to fit inside the core box exactly where the core box

side was taken away, as mentioned. This takes the place of the board removed, thus providing for keeping the sand in. A few holes cast in assist the venting. Two half-moons, one each side to fit in bottom of core box, in the two half-round parts, are required on the opposite side of core box marked Z Z (Fig. 7). The other ribs, stretcher, brackets, etc., two of a kind, are required, and the pattern maker's assistance for an hour will suffice for the production of a good core-iron to suit the core.

The same procedure is adopted as in making an ordinary box part or flask part in a general jobbing shop, run open-sand; the rougher and more jagged this core-iron casting is the better it will hold the sand. It must be noted that only one iron is required for the whole core, and so made that it will fit all over the bottom half of the core box only, say, within one-half inch anywhere, except bar X X, and the two half-moons Z Z (Fig. 7). These three portions actually rest in the core-box bottom, and eventually, at the same places, take the weight of the core when placed in the mould. These "touching" parts of iron will meet and rest on pieces of iron, bedded directly and touching under the core prints of the pattern, far enough away from the pattern proper to ensure that no hot metal at pouring will meet them.

The core iron having been made, is placed in the core-box, the projecting pieces E E E E, Fig. 8, extending some 6 in. beyond the sides of box. This distance will be subject to clearance space in the box part of the mould. It may be found advisable to have holes for chain hooks in the core iron, instead of these projecting pieces as shown, but this is a detail.

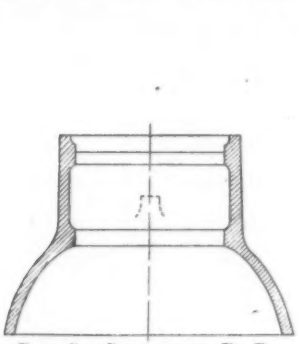


FIG. 5.—SECTION ON B B.

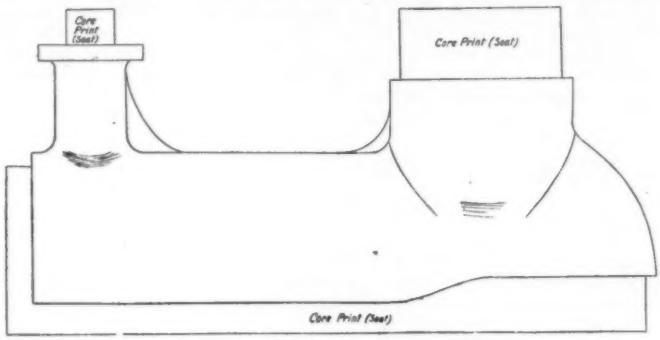


FIG. 6.—SIDE VIEW OF PATTERN.

The top of the iron will be about level with the joint of the core box, and when rammed up, as in ramming a green-sand mould, and straightened off, becomes a platform or bed to carry the other half of the core. Before placing the second half of the core-box on top of the bottom half, the necessary venting should be attended to. Nothing extraordinary is required, but it should be done well.

All is now ready for the second half of the core box. Having fixed it true and straight on its fellow (the side board having been taken off as in the bottom one), a fairly heavy weight should be placed on top to hold the pair firmly together while ramming. This top half of the core contains no core iron, as none is necessary. It will, of course, be made up of pieces of coke and the usual ashes, etc., in its interior. A few blows in the usual way around the top half of core box and it will come away without much difficulty. The chains should now be arranged to take up the whole core by "hanging on" at the four projection pieces E E E E, Fig. 8. If any portion does not "lift" quite clean underneath, it is easy to dress and mend up while the core is slung in the chains. In the event of a somewhat nasty draw, a useful commodity to have handy is plaster-of-Paris. The common cheap grade used by builders serves excellently. With a can of old waste oil and a little knack, a moulder will soon make a plaster cast off any particular part of the core box that does not lift (it will take, of course, two plaster casts to get what he wants). He can then use this plaster "make-up" with every confidence, knowing that he has every chance of his mending-up being quite correct.

It is a matter of opinion whether to put blacking

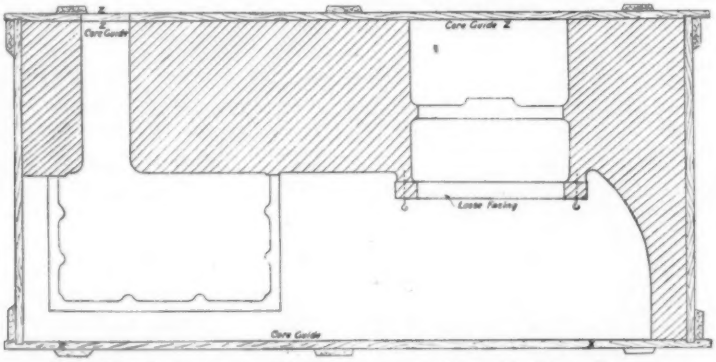


FIG. 7.—CORE-BOX IN HALVES THROUGH LINE D—D IN PLAN.

on dry or wet; both methods take up some little time. The first is slow and tedious, the other requires heating to distribute the moisture. The blacking having been done, coring-up proceeds. This is quite well accomplished with a little patience and perseverance. Contrast the making of these cores in dry sand. The latter involves two separate halves, made and treated independently; each half requires a special iron, one for bottom and one for top; and arrangements must be made for turning one half over after drying, not forgetting the necessity of fastening the two halves together. Does not this making of a core in two halves (dry sand) and the putting together account for, in many instances, the different variations of dimensions in the castings made from the same patterns and core-boxes, and often made by the same men, and, so far as possible obtainable, under the very same conditions?

The veriest boy in a foundry knows that where green-sand cores can be possibly used at all,

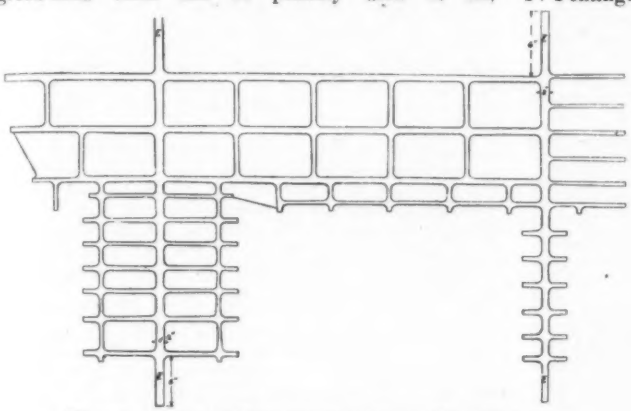


FIG. 8.—PLAN OF CORE-IRON, SHOWING EXTENSIONS AT E, E, E, E, FOR LIFTING.

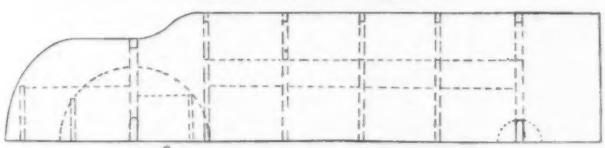


FIG. 9.—SIDE VIEW OF CORE-IRON.

dry-sand cores are out of the running at once. The essential factors are a good, sound, strong and rough core-iron, and a moulder with confidence not trammelled with nerves. Green-sand cores, unlike dry ones, do not expand, and can always be put back again into the core box. This applies to both large and small; therefore, we can rely on accuracy. Not so with dry sand, and it is often surprising the amount of expansion that has taken place during drying. This expansion of dry-sand cores is always before the pattern-maker when setting out his core-boxes, particularly if they are of some size.

The difference between the cost of fettling or dressing castings made by the two systems needs no comment.

British Foundrymen's Association.

Lancashire Branch.

The final meeting of the session 1913-14, was held at the Manchester Municipal School of Technology, on Saturday, May 2, Mr. J. Simkiss in the chair.

The CHAIRMAN said that the results of the past session had been very gratifying in many ways; certainly they had been to himself personally; and on several occasions the time limit had not allowed of the discussions, being as long as some of them would have liked. That, at any rate, showed the interest taken in the Papers by the members, and was a good sign in itself. His term of office expired that afternoon, and they would accordingly have to elect his successor. Before leaving the chair, however, he wished to thank the members for the uniform kindness they had extended to him, and for the assistance he had received in the discharge of his duties. There had been a net increase of 20 members since May, 1913.

The election of officers was then proceeded with as follows:—*President*: Mr. T. W. Markland. *Vice-Presidents*: Messrs. H. Sherburn and O. Stubbs. *Council*: Messrs. W. H. Sherburn, R. W. Kenyon, F. Penlington, J. Simkiss, F. Andrew, T. G. Hilton, J. Hogg, A. L. Key, A. Sutcliffe, S. Roe, J. Hargreaves, G. Barnes, J. Whittam, J. Robinson, A. Samson, and W. H. Smith. *Auditors*: Messrs. H. Grandidge and W. Barningham. *Secretary*: Mr. A. Harrison (unanimously re-elected).

The SECRETARY, in the course of his annual report, wrote that while they had had a full programme of Papers during the session, he regretted they had not had one that could be considered practical from the worker's point of view, though he hoped the members had learned something from them. The general attendance, while good, had not been up to the standard of the previous year. One visit only had been made during the session, but arrangements for others were under consideration. The annual dinner was held on January 10, when 68 members and visitors were present, and spent a most enjoyable evening. The Branch now had one life member, 38 members, 95 associate members, and 40 associates—total 174, an increase of 20 as compared with twelve months ago. The balance sheet for the year ending December 31; 1913, showed income £17 19s. 5d., including the sum brought forward, and expenditure £14 0s. 7d., leaving £3 18s. 10d. in hand.

The report was accepted with a hearty vote of thanks to the Secretary for his services.

Discussion on Foundry Problems.

The CHAIRMAN said that concluded the first part of the business, and they were now open to discuss any foundry problem introduced.

MR. A. L. KEY gave a sketch of a furnace, the lining of which had been reduced in thickness at 3 ft. 9 in. from the top. They had had a good deal of trouble with it at one time and another before having it relined. On recently visiting the furnace one morning, he discovered that the brickwork below had fallen down, and the question was as to what had caused the fall. It was the brickwork inside the lining that had fallen, though the man who repaired it said he could not find anything wrong with it. From the fallen brickwork to the charging door, the distance was 11 ft. 9 in. The furnaceman declared that the furnace was left in its ordinary state on the previous evening. During the day about 8½ tons of iron were put through.

A MEMBER remarked that it was possible the pig-iron struck the brickwork when it was being thrown into the furnace, and, in his opinion, it would be advisable to have the upper part strengthened, say, for some five or six courses downward.

MR. HOGG said that if cast-iron bricks placed at an angle were used near the charging door, it might do away with the difficulty.

MR. KEY replied that cast-iron bricks would have to be used too low to be of any real benefit; and being within the fusing line and having regard to the conditions under which the furnace was used, they would soften. It was a year and nine months since the furnace was altered, and they had had no trouble until recently.

MR. SIMKISS said that in his experience it was found that the whole of the brickwork gradually wore away. He thought the trouble was caused by contraction taking place at a particular point which he indicated on the sketch.

MR. SUTCLIFFE believed that if when relining extra sized bricks were put in here and there, they would serve to support the other brickwork.

MR. KEY replied that he quite appreciated the suggestion, but it would be rather expensive to work it out.

MR. ECCLES thought the mischief was more or less owing to the way in which the furnace was charged. He would like to know if the entire damage was opposite the charging door?

MR. KEY: Yes.

MR. ECCLES continued that such being the case, it was a clear proof to him that the cause lay in the throwing in of the pig-iron.

MR. PENLINGTON said in his opinion there had been some neglect on the part of the furnaceman in working the cupola. He had not experienced the same trouble himself, but he had frequently been troubled by the sinking of the brickwork. It was quite possible the blast had been kept on too long after the melting was complete.

MR. KEY remarked that the furnaceman when questioned declared he had done just the same on that particular day as he had always done. His own theory was that at a particular point (referring to the sketch) the heat was sufficient to make it expand, and it expanded to such an extent that it ripped the lining.

MR. SIMKISS said the problem had arisen in Mr. Key's case, but it might never happen again.

MR. ROBINSON: It fell down apparently because it was burned or worn out.

MR. SIMKISS observed that that was his argument.

MR. ROBINSON did not believe the man had checked the fan.

MR. SIMKISS advocated the use of the Bristol Recorder as the best method of checking the blast pressure, especially if the man could not stand all day over his work.

A vote of thanks to the chairman concluded the meeting.

The Reviving of Old Moulding Sand.

As is the case with most materials, foundry sand, in time, considerably depreciates, and loses its original good qualities. Owing to the action of the fluid iron, the sand gradually becomes less and less suitable for use, and therefore needs constant freshening by the addition of new sand. The latter is often a very costly item, especially in the case of foundries that are located some distance away from the source of supply, necessitating heavy transport charges.

In connection with this matter, it is interesting to learn that a patent has recently been granted for a method of reviving old sand, and rendering it fit for further use, in quite a new way, and which would appear to be capable of bringing about considerable economy in the cost of foundry work. The feature of the process is that a pre-determined quantity of sulphated clay or other soluble clay compound is added to the sand, which gives the latter the binding qualities that are necessary to enable it to be used again for moulding purposes.

The use of sulphated clay for such a purpose is not a new proposal, but hitherto this has not been directly added to the sand, but used only for the preparation of silicated hydrates, silicated clay, and other clay silicates or alkaline earths intended to be mixed with the sand. Such materials are, however, not soluble and do not give to the sand the necessary binding qualities already mentioned. It is to overcome these drawbacks that the new process has been worked out, and which consists in the direct addition to the sand of a mixture of sulphated clay, or a combination of this with a neutral gelatinous siliceous earth.

According to the patent, ordinary sulphated clay of commerce or other soluble clay, is ground in a dry condition to a fine powder, which is then mixed with the old sand, a certain quantity of water being added. The clay can be rendered soluble by putting it, in lumps, in hot water, or the clay material can be ground and then mixed into a paste with water and afterwards added to the sand.

The following description of one method of carrying out the process is taken from the "Eisen Zeitung":—Sulphated clay is mixed with water in the proportion of one kilogramme (2.2 lbs.) of the former to 12 kilogrammes (25.2 lbs.) of the latter, Seventy kilogrammes (154 lbs.) of the solution are then added to each ton of old sand that is intended for moulding. Where the sand is to be used for core or dry-sand moulding work, the proportion of the solution to the sand should be slightly increased. To give greater firmness to the sand, a certain quantity of a neutral gelatinous siliceous earth can be added to the sulphated clay. In this case, equal proportions of the two should be mixed, about 70 kilogrammes of the mixture being added to each ton of sand.

It is added that a simple solution of sulphated clay is best for sand intended for cores and dry moulds, and the mixture just mentioned for green moulding sand.

AMERICAN SOCIETY FOR TESTING MATERIALS.—The seventeenth annual meeting of the American Society for Testing Materials was held at Atlantic City from June 30 to July 3. The fourth and fifth sessions were devoted to steel, as follows:—Report of Committee A-1 on "Standard Specifications for Steel"; Report of Committee A-4 on "Heat Treatment of Iron and Steel"; Report of Committee A-8 on "Standard Specifications for Cold-Drawn Steel"; Report of Committee A-6 on the "Magnetic Testing of Iron and Steel," "Magnetic Habits of Alloy Steels." "A Failed Axle and the Investigation of an Internal Transverse Fissure," "Uniform Hardening of Steel"; Report of Committee A-3 on "Standard Specifications for Cast Iron and Finished Castings," "Some Notes on Chilled Iron"; Report of Committee A-2 on "Standard Specifications for Wrought Iron," "New Vibratory Testing Machine and Results Obtained by its Use."

Crucible Furnace Construction.

By Walter J. May.

In the ordinary works where crucible furnaces to melt various metals and alloys are required largely (apart from tilting furnaces, which, although costing a relatively large sum are eventually the cheapest), built furnaces are as useful as any if properly arranged. They can be built to melt anything up to wrought iron, and provided proper allowance is made for space they will take up to crucibles holding 2 cwt. of metal, this being the largest size which can be lifted with any degree of convenience to the furnace men. The object to be aimed at is the maintenance of perfect combustion of the fuel without drawing the heat out of the furnace more than possible, due regard being given to the class of coke used, though generally it may be taken that hard furnace coke gives the best all-round results, and in addition works out at less cost per ton of metal melted than any other fuel, gas coke not excepted.

As built crucible furnaces are worked under natural draught, a chimney of sufficient area and height is a necessity, and generally speaking an area of from one-eighth to one-quarter of the total fire-bar area is a necessity, while a height of from twenty to thirty feet will have to be provided according to position and the number of furnaces grouped to each chimney. In cases where each furnace has its own chimney, an area of not less than sixteen square inches should be allowed, although

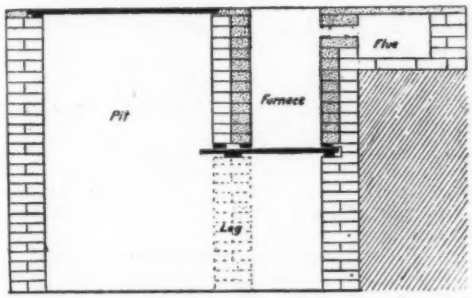


Fig. 1.—Section showing Crucible-Furnace Construction.

this is cutting the matter very fine. The air friction on the walls of chimneys has always to be considered and relatively this is more in a small than a large chimney when the cross area is considered. All chimneys should be governed by sliding dampers to regulate the draught to meet atmospheric and working variations, although such dampers do not possess all the merits which are often supposed to belong to them. There should also be a fairly large soot-door at the base of each chimney to permit of the removal of dust from time to time, as this accumulates pretty freely, although little actual soot occurs. The use of one chimney to each furnace is no great advantage, and one chimney to, say, six furnaces is quite enough, provided its area is sufficient in regard to the firebar area, and height of the chimney; but in grouping furnaces considerable attention has to be paid to the horizontal flues to which the furnaces are connected. Wide and shallow flues give the best results, and if these are about eighteen inches wide and eight or nine inches deep, they give excellent results where groups of six furnaces are concerned. The smoother both flues and chimneys are inside the better, as there is then less friction, but beyond having smoothly-laid brickwork, it is rarely necessary to provide anything else. The inlets into the flues should be at least one course of bricks above the inside floor, or dust will prove a source of trouble, and it will be necessary to clean out the flues occasionally.

The pit in which the furnaces are built should be about six feet deep when finished, and should give at least three and a half feet in front of the furnaces to provide room for working, and to admit air in sufficient volume for the supply of the furnaces, otherwise there is some chance of poor melting at times. If there is any restriction of the air supply, combustion is reduced, and with it heat. For the better distribution of the air it is also better to have "legs" or piers on which to support the furnace bodies, as these have advantages over solid walls.

The furnaces or "fire holes" should be square in cross section, and should allow a clear space of three inches or more between the wall and crucible. Usually two sizes of furnace will be desirable, at least one twelve-inch hole being required for small melts. The same care must be taken with the small fire holes, however, as regards provision for obtaining full combustion of the fuel, as probably as much, if not more, refractory metal will be dealt with in small quantities as in large. As considerable heat has to be resisted by the walls of the furnaces, they should be of the best class of firebrick obtainable, and as only a lining is needed, this refractory brickwork need only be about four or five inches thick, the backing being of ordinary bricks. The lining bricks should be rubbed down true, and should be well wetted before laying in position, as the joints have to be as thin as possible; in fact, the bricks should touch, the jointing material only filling up insterstices. Either well-soaked fireclay or very finely-ground ganister should be used for jointing, and should be in a somewhat sloppy condition so that all excess will squeeze out when rapping the bricks together. The fire surface of the bricks must be kept quite smooth to prevent as far as possible slag getting a lodgment, because adherent slag destroys the lining more than mere heat, and the removal of cold slag is usually disastrous to the brick furnace lining. Of course, slag should be removed with a slice while plastic, but then very often it is not.

Properly, the depth below the firebars should be the same as the height of the furnace above the bars, but this is not always possible owing to local conditions, but still it is a good thing to aim at and it gives more confidence to know that there is plenty of room for ashes, and that there is no fear of choking the draught.

The pit should be covered with an iron grating made in sections easy to lift, and with bars stiff enough and close enough to be walked on freely. Both grating and furnace top should be level, and not only level in themselves but level with the floor, as molten metal is nasty stuff to play with. Some form of lifting apparatus with blocks and chains should also be adapted to the furnaces, as this lessens the labour in getting the crucibles from the furnaces.

while if, in addition, the crucibles can be carried to some particular point for skimming, this very largely assists in the recovery of waste, a point that usually means money for waste products, these being saleable when clean.

All brickwork to be subjected to heat should be thoroughly dry before firing, and time is an important factor in drying out brickwork of any kind. This should always be remembered with all classes of fire work, because lack of drying is the most fertile cause of failure.

A cross section of a furnace, pit, flues, etc., is given herewith as some guide to erection, but as a rule, it is necessary to prepare drawings for each particular case, as usually conditions are different with each set of furnaces put in, although the general principles are the same. The "leg" is shown by dotted lines, and firebrick and tiles are shaded.

British Foundrymen's Association.

Newcastle-upon-Tyne Branch.

At a meeting of the members of the Newcastle-upon-Tyne Branch of the British Foundrymen's Association on May 30, the report of the Branch Council was presented. The membership showed a net gain of 16 over the previous year, and totalled 91.

Discussion on Foundry Problems.

A discussion on foundry problems followed, Mr. Paulin occupying the chair.

Mr. Matthews raised the question of test bars, their position on the casting, how attached, and whether cast on horizontally or vertically. There was, he said, a diversity of opinion as to the effects of variations in these matters, and it was once said by a member of the Association that test bars only held a nodding acquaintance with the castings. That was a very startling statement to make, and one which he thought should be challenged.

Mr. Paulin said that was a question he was exceedingly interested in, both as regarded cast iron, gunmetal, and steel. Of course, in steel castings the test bars were cast a different way. He understood a large slab was cast off a part of the casting, and was sawn into strips, but such a procedure could not be effected very well in cast iron; it could be done in gunmetal, but it would be rather expensive, and there was not the demand for the number of test pieces from gunmetal that one required from steel. Generally speaking, steel castings were a very big matter, and Lloyd's or any other classification society might require several test bars from the one piece. In the course of certain work recently he had test bars to cast—he did not lay himself out for work that required test bars, as in his opinion it was rather foolish to indulge in both Admiralty work and ordinary merchant work—and the box he had prepared for repetition work would not do for test bars. He therefore asked if they would agree to having the test bars cast separately from the same iron, and they did, and there was never any trouble when that was done. It was the same iron, but owing to the mere fact that it was cast separately it gave twice the result. The nearer the bar was to the casting the more it was under the influence of the heat that was in the casting, and the longer it was in cooling, the more flaked graphite was allowed to separate out and the tensile strength was reduced.

Mr. Gallon said he always cast them as far off the job as he could.

Mr. Paulin next drew attention to the questions of whether a test bar should be run in the centre or in the end, and whether it was better cast perpendicular or horizontal.

Mr. Rang thought that everybody was agreed that to run the bar from the centre was bad.

Mr. Paulin said where it was cast horizontally the middle would certainly be a bad place.

Mr. Archer said it was his experience that if the test bar was far off the casting it did not get the necessary amount of pressure.

Mr. Matthews said that one man's experience was that a test bar ought always to be cast horizontally so that when it was full there would be no further disturbance of the metal. He (Mr. Matthews) prepared them perpendicularly, and preferred to have the metal flowing all the time; the outside of the test bar began to freeze, but there was still a core of molten metal flowing through.

Mr. Gallon said the strongest test bar was got by casting vertically, so that the metal could not flow through after it reached the top.

Mr. Paulin discussed the possibility of casting test bars something like the shape of the finished bar, so that the smallest amount possible would need to be machined from them before making the test, because the nearer they were made to the finished size the higher was the tensile strength, and the nearer the material was cut down to the centre the weaker it would be.

Mr. Gallon contended that a bar cast on end was denser at the bottom than at the top.

Mr. Matthews considered that there was very little in it.

Mr. Clark stated that he had seen cylinder covers cast on edge in an 8-ft. body, and they would not stand 454 lbs. pressure, but when cast on the flat they would. The object in casting them on the edge was to get them to stand pressure, but they stood more pressure on the flat.

Mr. Paulin said that in dealing with the advantage of one method of casting over another, one should be careful at the outset to start with similar mixtures, or the whole of the deductions might be unsound.

BIRMINGHAM FOUNDRYMEN'S EXCURSION.—The annual summer excursion of the Birmingham Branch of the British Foundrymen's Association took place on Saturday, June 20. A party of fifty, including ladies, journeyed during the afternoon to Stratford-on-Avon. The greater number took advantage on arrival of an arrangement for viewing Shakespeare's birthplace, and Ann Hathaway's cottage. Additional interest was given to the visit at Stratford by the fact that the annual regatta was in progress, and most of the party spent what remained of the afternoon in the Bancroft Gardens watching the contest. Tea was served at the River Restaurant, Mr. C. Heggie (President) being in the chair, supported by Professor T. Turner and the officers of the Branch. On the motion of Mr. Dalyrmple (Vice-President), seconded by Mr. R. Buchanan, a hearty vote of thanks was passed to the Sub-Committee which had made arrangements, with particular mention of the President, Mr. H. Winterton and the Hon. Secretary (Mr. Grindlay). After tea most of the party enjoyed a steamboat excursion up the river as far as the Rapids.

A Method of Making Tin Phosphide.

By Charles Vickers.

Tin phosphide or phosphor-tin, as it is commonly known in brass-foundry parlance, is a very convenient form in which to add phosphorus to bronze for deoxidizing purposes, or for the production of phosphor-bronze. In appearance phosphor-tin bears considerable resemblance to antimony, as its structure consists of large crystals and the metal is very brittle. The content of phosphorus in commercial phosphor-tin is liable to variation, but never exceeds 5 per cent. It is probably better to purchase the phosphor-tin rather than to attempt to make it in the foundry if it is obtained from a reputable maker who will guarantee it to be pure. The man who makes his own phosphor-tin, however, has the advantage of knowing exactly what is in it; he is sure that it contains no lead when "Straits" tin and yellow phosphorus have been used in its manufacture.

For use in making bearings or other castings containing lead, a little of the latter element in the tin would of course be an unimportant matter, but for castings that are required to conform to rigid specifications in the way of tensile strength and other physical properties, it is important that lead be conspicuous by its absence.

When phosphorus is added to metals that are molten, a large amount is unavoidably wasted, as the phosphorus floats on the surface of the liquid and burns, and the lower the melting point of the metal the greater the waste of phosphorus. Thus, when phosphorus is added to molten tin, the phosphorus, being damp, causes an explosion which throws out some of the tin and scatters a part of the burning phosphorus, and this is repeated with every fresh portion of the phosphorus that is thrown on to the tin, resulting in a considerable loss of the tin and an enormous loss of phosphorus, so that the resulting alloy rarely reaches the crystalline stage that indicates a high phosphorus content.

Although the spattering of molten tin can be greatly lessened by covering the tin with a layer of powdered charcoal, the manufacture of phosphor-tin by the addition of yellow phosphorus to melted tin is impracticable because of the waste of phosphorus, and no particularly marked improvement in this respect is possible by first copper coating and drying the phosphorus. Phosphor-tin can be made very easily, however, if the tin is first granulated, then melted with the phosphorus. It is not at all necessary to have the tin in a finely-granular condition, as would be the case if it was precipitated from a solution by the addition of zinc, as is sometimes recommended. All that is necessary is to have the tin shotted, and this can be easily accomplished by pouring into water.

To produce the shotted tin, an oil barrel should be filled with water, and for convenience in removing the shotted product, a large iron kettle or other vessel with a rope attached to the handle should be placed in the bottom, so that it can be raised out of the water to recover the metal after it has been poured. An iron plate can be placed on top of the water barrel, on which to rest the crucible when pouring the tin.

The tin can be melted in an iron ladle if found preferable, as the method of melting is unimportant. It is necessary, however, to pour the tin as cool as possible, and in a very thin stream, as there is a tendency to spatter. For this reason it is advisable to use a long-handled ladle, or crucible tongs, and to stand in such a way that if any metal spatters it will not be likely to strike the face of the operator. The product of this method of "shooting" is flaked rather than shot tin, and these flakes are so thin that the metal becomes very light and bulky, so that a few pounds of melted tin will make a relatively large mass of flakes. This is all the better for the purpose of making phosphor-tin, as the larger the mass of tin the easier it is to embed the phosphorus therein.

After the flaked tin has been recovered from the water barrel, the water should be drained off and the tin be allowed to dry. If the drying is accomplished by the application of heat, great care will require to be exercised in order not to melt the tin, as when in the condition of flakes it melts with the greatest ease. It is not necessary for the tin to be entirely dry; but it must be quite cold to avoid the possibility of accidentally inflaming the phosphorus, which might be attended with disastrous results. A new crucible should be used to make the tin-phosphide, the crucible having been previously annealed, but at the time of use being quite cold. In the bottom of the crucible a layer of the flake tin should be placed, and on this a portion of the phosphorus charge, then another layer of tin flakes, on top of these more phosphorus, then more tin, until the crucible is full, or the phosphorus is exhausted, care being taken to see that a thick layer of tin is on both the top and bottom of the crucible.

The charged crucible is then placed in the furnace, and the tin melted at a gentle heat. When the heat reaches the phosphorus the latter will inflame, melt the tin, and combine therewith to form tin-phosphide, after which the crucible can be removed from the furnace and the contents poured into ingots. The quality of the product will, of course, depend upon the amount of phosphorus that is added to the tin, but it may be given as a rule that about 8 ozs. of phosphorus to 9½ lbs. of tin is the maximum proportions to be used. Theoretically, this would produce a 5 per cent. phosphor-tin, but practically it will not produce that alloy, because there will be some unavoidable loss of phosphorus. The alloy, however, will be strongly crystalline, and the method will be found a very simple and efficient way of preparing phosphor-tin.

The same method can be used for the production of phosphor copper, only in this instance more phosphorus can be combined with the copper than with the tin. As high as 15 per cent. phosphorus can be combined with copper, but probably an alloy of 10 per cent. phosphorus will be the best to make in the brass foundry. The copper should be granulated by pouring into water, only it should be poured from a greater height than in the case of tin; or, as an alternative, clean copper turnings can be used. The phosphorus should be well buried in the granular copper, and the latter quickly melted. A cover may be luted on the crucible, if thought necessary, but this is not really required if a little powdered charcoal is strewn on the top of the copper.

An excellent alloy of phosphor bronze is made by melting 90 per cent. copper under a cover of charcoal, and adding 5 per cent. pure tin and 5 per cent. of the phosphor-tin above described.

The Question of Costs in the Foundry.

By A. O.

Most foundries have some method of working out the cost of production of the castings they make, but it is quite evident, from a comparison of quotations, that some of the methods employed are faulty, resulting in too high or too low estimates, or that some foundries are run at a greater expense than others.

In foundries where the work is of a standard character year in year out, the task of obtaining true costs should not be very difficult, but in foundries dealing with work which is always varying in requirements as to quality, and the amount of labour necessary for production, the question of costs requires constant attention. Sometimes foundries take on work at prices which might be described as similar to giving change for a shilling, with the object of keeping their output up to the safety level, and to help to reduce the charges which would otherwise fall heavily on other jobs. If foundries did nothing worse than giving 12 pence for a shilling, or value for value, instead of giving, say, 14 pence for a shilling, they would not go far wrong. But some are not always able to say honestly that they are getting value for value, and too often it occurs that one firm endeavours to learn another firm's prices, so as to be able to quote lower to secure the patronage of the rival firm's customers, even though that price means working either at a loss, or on a very narrow margin of profit, with no allowance for the accidents which occur in all foundries. Few firms will confess to having acted in this manner, but some even contend it is a good move; though generally it is termed dishonest—when the other firm does it.

The average foundry owner would welcome some means of uniform costing in similar branches of the trade, though in this country the matter is very seldom discussed. The practical foundryman should be consulted when estimates are being prepared, and should be given such information as will enable him to exercise economy whenever possible. He on his part should be capable of using such information. If the necessary factors are not supplied, he will be in the position of not knowing whether his foundry is paying or not, and though he will rarely admit the latter, he will be in the dark, and perhaps in the hands of a superior who is never satisfied and blames lack of success on the wrong cause.

Other conditions being equal, it will be found that the lower the output the higher the charge for each ton of metal melted. This means that in changing from a moderately heavy and solid class of work to a lighter and more complicated class of work, the costs will increase rapidly in several directions. More expensive metal will be required, and this must be melted hotter, thus affecting coke consumption and cupola practice. Output in tons is lowered, and the liability to wasters increased. New plant, more or less expensive, will be required, and the labour cost will be increased.

The method of checking time should be such that each job gets its proper portion. Although it is not advisable to have skilled men doing work which could be done by unskilled labour, it is not always avoidable, though it occurs more in some foundries than others. For example, from half an hour to one hour or more may be spent by a moulder each day in mixing sand, removing castings, hand lifting, carrying metal, etc., according to equipment or organisation of the shop. In a shop engaged on medium-sized jobbing and small work, a moulder may spend one hour in the early morning getting out previous day's work and mixing his sand in preparation for a start. He then starts on a job which takes up two hours in actual moulding and if no allowance is made for the bad start, he has to book three hours to that job. Taking his wage at, say, 9d. per hour, 10 hours daily, the moulding cost would thus show 2s. 3d. If he made the job later in the day some other job would have to stand the bad start, and the moulding cost would be put down as 1s. 6d. If casting and feeding is in progress during the moulding operation, the moulding cost would perhaps be put down as 2½ hours, or 1s. 10½d.

Although the allowance of one hour for a bad start does not stand for every shop, the bad start is there, and in this case neither of the three amounts, namely 2s. 3d., 1s. 10½d. and 1s. 6d., would be right. A better plan, is to set down one hour as mixing-up-time, etc., and put the burden equally on the other nine hours as follows:—Instead of 10 hours at 9d.= 7s. 6d., say 9 hours at 10d.=7s. 6d. This would make the cost of the job in question 1s. 8d. for moulding time, and each job would share the cost of mixing. If this is not done it would pay a customer to get his jobs made in the middle of the day, if he could possibly manage it, or at any rate, not in the early morning. The writer has known this bad start to extend over 3½ hours, with two men engaged on a job, and in another case the bad start has been only half an hour.

The equipment of the shop is another factor affecting costs and in a jobbing shop causes great differences. The well equipped shop has the advantage of being able to take on almost any class of work, but when the output is low the charges fall heavily on those jobs remaining, while on the other hand the shop poorly equipped suffers through inability to take on any class of work, though the charges are lighter during times when the output is reduced. Needless to say, this matter requires consideration and a good view ahead, when transforming a shop and discarding old tools for new ones which are more expensive to keep when the output is low.

The lighting of a foundry is important, and there is no light better than daylight, a fact which is not always appreciated so far as foundries are concerned. Bad light many times means work of a poorer quality; and castings somehow always come up for inspection in a machine shop with good light. Probably if examined in the same light that prevailed during the making, fewer faults would be found.

In shops consisting of several departments, each should have its charges separate as for power, equipment, superintendence, general and skilled labour, as it would be unfair to compare two departments doing a similar class of work, one well-equipped and up-to-date, the other out-of-date.

Area of floor space should also be considered. It often occurs, however, that with separate charges for each department, there is a tendency for one to prev on the other, both as regards one foundry with another, and drawing office, pattern-shop and foundry, which is seen in lack of detail in drawings, badly finished patterns and the use of tackle by one foundry at the expense of another, where the foreman will

see to its being made, even though it counts against him in temporary reduction of output. In such cases it is for the foreman to look after his own department and prevent such occurrences.

Another factor affecting costs is the condition of the shop. In this respect the untidy shop suffers through time wasted by moulders looking for tackle that is perhaps buried. Every man or gang of men should be held responsible for the floor around them and a place be provided for sprigs, gaggers, wedges, chaplets, irons, etc., for their return after being liberated or left over. Every moulder has to manage to get tackle from somewhere and it often happens that one man is looking for tackle which is stored up by another man for a day or two later. Such selfishness would be avoided or at any rate discouraged, and a man would either want new tackle, if there was none in the customary place, or could go on with another job till certain tackle was liberated, instead of looking for what he could find.

Index Card for Foundry Patterns.

One of the most thoroughly organised machine-building establishments in Europe uses for its foundry patterns a register card such as is shown herewith, the peculiar feature being a small blue-print dimensioned to scale, of the pattern itself, with the drawing and pattern numbers thereon. A translation of the wording on either side of the card is as follows :—

PATTERN CARD. DRAWING NO. ..... PATTERN NO. .....

Pattern No.
Article.
Pattern Material. Weight.
Old Pattern No. From Drawing No. (Dimensioned blue print, 50 × 75 mm.)
.....parts. Replaced by Pattern No.
.....sweeps. To replace Pattern No.
.....core-box parts.
Pattern made by..... Date ..... 191.....

WHERE FOUND.

Department.	Building.	Storey.	Shelf.	Department.	Building.	Storey.	Shelf.

Sent to	Date.	Remarks.	Sent to	Date.	Remarks.

Actual Cost of Pattern, including Upkeep, Changes, and Replacements.

	Material.		Labour.		Burden.		Total.		
Pattern.									

USED FOR.

Order No.	No. Castings.	Date.	Order No.	No. Castings.	Date	Order No.	No. Castings.	Date.	Order No.	No. Castings.	Date.

It will be noticed that the back bears a record of the amount of use of the pattern in question, the number of times, and the number of castings each time used.

Simple Tests.

By H. Spencer Kipling.

Many foundries have too small an output to justify the establishment of a chemical laboratory. In others the foreman is hampered by the cheese-paring policy of those who do not realise the value of modern scientific investigations. The writer proposes to describe a few tests which can be very easily carried out by the foreman himself without outside assistance.

Whilst the complete analysis of a substance requires training and long experience before accuracy is attained, many materials can be examined for adulteration without difficulty. Keen powers of observation and a little manual dexterity will often prove very fair substitutes for the more accurate methods. By systematic testing of the materials any sudden variation may be detected and then made the subject of an analysis by an outside chemist, whilst avoiding the expense of analysing samples at random, as is too often the custom of those foundries who are compelled to rely on contract analysis.

There was a tradition in the laboratory of one firm with which the writer was connected, that in days of old the silicon of pig-iron was determined by pouring dilute acid upon the sample in a tall beaker, and after allowing the reaction to proceed for a certain number of minutes in a warm place, applying a rule to the side of the beaker and measuring the depth of froth, which varied according to the amount of silicon present. If any reader cares to try this for himself, a cheap tumbler as narrow as possible should be used, but the results are largely dependent on the experience of the worker, being affected greatly by altered conditions. It is, of course, necessary to have as a standard a sample of known silicon percentage.

The tumbler referred to will possibly be more usefully employed in the following examination of ganister. (It is a curious fact that red brick and similar rubbish has a distinct tendency to disguise itself as "ganister.) The tumbler is half-filled with ganister and a gentle stream of water run into it from a tap whilst stirring steadily with a piece of wood or a clean wire, catching the overflow in a clean bucket. This is continued until the water flows off clear. The material remaining in the tumbler is dried and carefully examined with a pocket lens. If the ganister is unadulterated the residue will consist of a bluish-grey stone with a small quantity of yellow gritstone, and probably a few particles of coal from the seam. (It is advisable to break the pieces to see their nature better.) On the other hand, pieces of brick, slag, and the like, are frequently seen, sometimes in such quantities as to force one to the conclusion that intentional admixture has been resorted to, especially if the ganister has been supplied at a competitive price. The fine material in the bucket should be allowed to settle, and be made into a test brick, dried gently and then fired. From its size and strength a good estimate can be made of the amount of clay present, as, of course, if the particles were simply fine ganister they would bind very feebly. A letter-balance will prove useful to supplement this test. The residue from the "washing test" if weighed will give a guide to the amount of clay present, if, as already mentioned, the properties of the brick are taken into consideration.

In a previous article (FOUNDRY TRADE JOURNAL, Vol. 15, page 718) the writer referred to the presence of excessive moisture in ganister. This can be simply estimated by means of the letter balance. A representative sample is taken, avoiding an excessive proportion of those parts which have obviously dried, or become wetted during transit, and the balance then loaded to its maximum. The weighed quantity is dried, say, in a core oven, covering it loosely to prevent contamination by loose dirt. It is then re-weighed, the loss of weight representing the moisture. Fire-clay should also be subjected to the same "washing test" to detect undesirable constituents.

Many foundrymen test coke by noticing whether or not it will sink in water. This test is rather dubious, as often if a piece of coke be broken in two, part will sink and part will float. Therefore, great care and experience are necessary to pass judgment fairly. An easy method of determining the density of coke is to have a box made exactly 12 in. cube inside. (It is an advantage to make it exactly 10 lbs. in weight to simplify matters.) It is filled with coke, weighed, and its own weight subtracted, leaving the weight of a cubic foot of coke. Care is necessary to pack the coke closely, and the test should be made on furnace-size of coke, and also on small coke, so as to get a fair average. This figure will be found of great value in determining the correct weight of coke for the cupola bed, as if the furnace dimensions are known, the volume of a bed is readily calculated, and if the cubic feet are multiplied by the weight of the particular coke, the weight of bed-coke necessary is given almost exactly, thus avoiding changes of melting zone due to use of unusually dense or light coke.

Dr. Stead has mentioned in several Papers before the Iron and Steel Institute very convenient and accurate methods of estimating phosphorus and sulphur in cast iron. It is to be regretted that these Papers are not more generally accessible to the average foundryman. To estimate phosphorus in a pig-iron or casting it is merely necessary to grind a small piece to a flat surface on an emery wheel, roughly polish on emery cloth, and immerse for a few seconds in dilute nitric acid (3d. of acid diluted with its own bulk of water will last a long time for this test). The specimen should then be rinsed in hot water and dried. A hematite iron will be darkened almost all over, with isolated specks of a brilliant whiteness, whereas a highly phosphoric iron will show a broad white network, and intermediate grades exhibit a proportionate amount of the white constituent (which is phosphide of iron). In the hands of an experienced man, this is a most valuable test. A pocket lens is usually of assistance, though often an examination by the naked eye is sufficient for the purpose.

Sulphur is estimated by preparing a similar polished surface, and laying on it for a few seconds a piece of bromide paper (ordinary gaslight printing paper from any photographic dealer), which has been soaked in 10 per cent. sulphuric acid (again 3d. worth will be an ample supply). The sulphur of the metal is evolved as sulphuretted hydrogen, which darkens the silver compound in the paper, so that the colour is proportionate to the amount

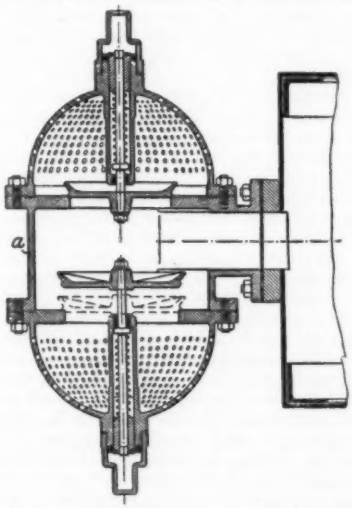
of sulphur present, and the print shows where the sulphur has segregated. If it is desired to preserve the print for reference, it should be well washed to remove the acid, and then preferably fixed in a solution of hyposulphite of soda (usually known as "hypo" and sold at 2d. per lb.), finally washing till the hypo is removed. This fixing is not absolutely necessary, but prevents the print from darkening all over if left exposed to a strong light. Each worker must make his own standards and adhere closely to conditions in order to make the test comparative.

In foundries where the tools of sprue-cutters are supposed to be made of "special tool-steel," a substitution of ordinary cast steel is readily detected by means of an emery wheel. A carbon steel throws off brilliant showers of sparks, but a tungsten steel (the usual special tool-steel) merely shows dull glowing particles instead of the bright stars. This is often a handy test if tools have been mixed in the stores.

A letter balance, pocket lens, two or three tumblers, packet of printing paper, a developing dish to soak the paper in, two bottles of acid, and the hypo, will together cost less than 10s., and if combined with painstaking intelligence will give valuable assistance to any foundryman who is unable to obtain the assistance of a properly equipped laboratory staff.

Safety Devices for Foundry Cupolas.

Hitherto the majority of protective devices against explosion in foundry cupolas have consisted of safety valves in the blast pipe or box of the furnace, to reduce the effects of an explosion, or in a throttle valve in the blast pipe, near the box, which is closed when the cupola is not to be used for some time, any carbonic oxide gas which would otherwise on the re-



New Safety Device for Cupolas.

starting of the blast mix with the air and become ignited inside the heated furnace, being thus prevented from passing into the blast pipe.

The drawback to the latter method is that it is not automatic in its action, and consequently is not always attended to, and it is with the object of overcoming this disadvantage that the Gesellschaft Waagner, L. & J. Biro, & Kurz, of Vienna, have recently introduced the automatic arrangement illustrated in section in the accompanying sketch. It comprises a vertical cylinder attached to an opening in the blast belt of the cupola, the cylinder having attached at top and bottom a cup-shaped perforated cover. In the lower part of the cylinder and its cover is located a valve, which is held open by its spring so long as the blast is not in operation, and only closes when the blast pressure reaches a certain pre-determined minimum. When the cupola is not in operation, air is free to pass through the holes in the lower cover and open valve to consume any carbonic oxide gas that may have collected. When the blast is again started, any remaining gas in the cylinder is driven out by the blast through the open valve and the holes in the cover, ere the blast pressure has increased to the necessary extent to close the valve.

The upper valve in the cylinder is normally held closed by its spring, and only comes into operation when the pressure of the blast becomes excessive and sufficiently high to overcome the power of the valve spring, it thus acting as a safety valve should there be any racing of the blower and its motor, or any clogging up of the blast nozzles. According to "Stahl und Eisen," to whom we are indebted for the illustration, the makers recommend the use of two of the safety devices for each cupola, and that they be placed on the opposite side to the tapping hole.

INTERNATIONAL ENGINEERING CONGRESS AT SAN FRANCISCO.—Among the general subjects to be treated before the International Engineering Congress, 1915, probably the one having the broadest interest is that of materials of engineering construction, which concerns all phases of engineering activity. The list of topics which will be treated in this section includes: "Slag Cement;" "Economics of the World's Supply of Iron;" "The Life of Iron and Steel Structures;" "The Employment of Special Steel in Engineering Construction;" "The Place of Copper in the Present Engineering Field, and the Economics of the World's Supply Thereof," and "Alloys and Their Use in Engineering Construction." Information concerning the Congress may be obtained by addressing the International Engineering Congress, 1915, Foxcroft Building, San Francisco, Cal., U.S.A.

STRAINS IN ROLLED BRASS AND BRONZE BARS.—In a Paper contributed to the "Proceedings" of the American Institute of Metals, Mr. James E. Howard deals with this subject, and in summarising the results of a series of experiments made by him sets forth the following conclusions:—(1) It appears that cold rolling introduces into brass and bronze bars opposing strains of tension and compression of considerable magnitude. (2) That annealing will relieve these internal strains. (3) That the presence of opposing strains of tension and compression in the same bar tends to cause early permanent sets when the metal is loaded, it being immaterial whether the applied load is one of tension or compression. (4) That the vagueness of an elastic limit in brass and bronze is accentuated by these conflicting strains. (5) That high elastic properties in either tensile or compressive directions require previous overstraining loads directly applied in the directions such gains are desired. (6) That no mechanical method capable of raising the elastic limits in both tensile and compression directions is apparent in the present tests. (7) That exposure to very moderate temperatures causes an appreciable annealing effect, and consequent lowering of the elastic limit of the metal.

Machinery for the Treatment and Mixing of Sands and Moulding Materials.

By Algernon Lewin Curtis, M.E.

It is almost impossible to decide upon any specific design of sand-treating or mixing machinery without first making a careful study not only of the foundry's local conditions, but also of the sands and materials used in the mixtures in question.

The design of a sand-treating plant to meet the local conditions of any foundry is rather a question of mechanical engineering than geological or chemical experience, as it is necessary to make the most use of the space available, which in existing foundries is usually rather limited. In the space conceded by the founder, mechanical ways and means have to be provided for automatically handling and treating sand to the best advantage at a minimum cost. While it is quite possible to design machinery capable of mixing and treating satisfactorily the component parts of a dry-sand, green-sand, loam, or core mixture, yet if one or more materials employed are unsuitable from the commencement, then machinery, however well designed or built, will be of little avail, as the final proof of the sand mixture's value lies in its physical and refractory qualities.

Sand and moulding-material mixtures, being generally composed of different new sands, old sand, coal and coke dust, ashes, sawdust, horse dung, and other organic matters sometimes known as "compounds" or "compos," depend for their physical and refractory qualities on the purity of the ingredients employed. Each ingredient is more or less a variable factor, though the coke and coal dust or compounds may be omitted within reasonable limits as negligible quantities as far as affecting the refractory properties of the other materials. The principal variations are those which occur in new and old sands. This variation is more magnified when more than one new sand is employed in a moulding mixture. Perhaps the first stage of variation in a new sand is evidenced at the pit or quarry, where preliminary mixing follows excavation and the rough grading usually undertaken by the mine or quarry owner. Such grading and mixing is generally carried out in a crude manner. Several cases have been brought to the writer's notice where quarry owners were spoiling their materials by neglecting to select and grade correct-working strata. During excavation sand is generally taken from different parts of the quarry or deposit without consideration of any difference in refractory quality as evidenced by the different strata. This material gets partly mixed during transit to either railway wagon or vessel. Its consistency, physical and refractory qualities are left entirely to the quarry owner. A moulding sand's formation and characteristics being usually unknown to most foundrymen, the quarry owner or merchant is generally relied upon to deliver materials most likely to suit the requirements. Should the merchant or quarry owner supply the founder with a sand which "cuts" and "scabs" castings, the latter complains, and tries a fresh material from another source. In this case both founder and merchant are disappointed, whereas if the merchant called in an expert to examine the material and find a solution, it would probably be found that by grading the sand correctly further supplies could be obtained equal to the original consignment.

If merchants or quarry owners supply sand of a consistency ready for use, then the addition of any old floor sand in the foundry makes it too weak for working, and causes "washing" besides much mending of moulds. If, however, merchants supply sands too strong for immediate use, then the founder has to break such materials down accordingly by the addition of old sand. Merchants and quarry owners usually obtain the same price for weak sand as strong; consequently they will generally supply weak (irrespective of refractory qualities), as selling the strongest sand means picking out the eyes of the sand quarry or deposit, besides giving the founder an opportunity of obtaining one and a-half trucks of sand at the price of one, because one truck of strong sand will last the founder longer than one and a-half trucks of weak. In order to try and balance matters, the quarry owner endeavours to mix the sand himself without any special knowledge of either geological chemistry or the requirements of modern moulding materials. This means throwing down coarse, weak, undercut, or partially main-crop material and mixing it with strong sand taken from different strata. All these materials, *i.e.*, the very weak, medium, and strong, being in different stages of decay, possess different individualities. Such differences represent a difference in physical and refractory quality which will react one with another in reducing the refractory value of the total mixture. It is therefore better for founders, especially those making steel castings, to employ an expert to select, examine, and test veins or strata in sand deposits than to rely on merchants' samples or the analyses of their own technical departments. The mine or quarry owner is no doubt correct in thinking his course of procedure a right and moral one, but the founder suffers through the former's inexperience.

This is well illustrated in the Belgian yellow and white-sand formations, where a pocket of perhaps 300 tons of splendid sand is sometimes discovered. Steel founders using sand for green-sand moulds from such a pocket may obtain absolutely clean-skinned castings at first, then after a time their castings begin to show signs of "scabbiness" and "sand-stick," which gradually gets worse. On investigation it is found that the sand, although from the same quarry, comes from a different part, and not the small original pocket, which has become exhausted. Until a fresh pocket in the correct stage of decay is discovered, no amount of mixing with other sands will suffice to give clean skins to steel castings made in green sand.

The above all tends to prove that it is the selection of raw materials which demands primary attention, machinery for mixing and treating being a secondary consideration. Founders, however, cannot always be experimenting, testing, and proving fresh deposits of sand in their foundries; consequently they rely on a merchant or quarry owner for the quality of their sands or moulding material, and depute a chemist to check its standard. This is an unfortunate method, as the merchant or quarry owner has not the founder's qualifications to guide him, and the founder not the time to visit the various quarries and select his own materials. The sand's standard or quality is therefore judged by chemical analysis. As mentioned in

previous articles, chemical analysis is a valuable help to founders (so far as sands are concerned) where the sum total of fluxes in a sand exceeds the prescribed limits, but with commercially refractory materials (and a proved moulding sand can be thus termed) it is impossible to reconcile analytical data with the physical conformity of such materials in practice within such limits. In other words, a new moulding sand may possess 2, 3, 4, 5 and 6 per cent. total impurities and yet produce first-class castings; but the difference between 2 per cent. and 6 per cent. total impurities is a large factor for the chemist to make light of. It might be mentioned here that colour is also little guide to the refractory quality of a sand, several cases having been brought very prominently to the writer's notice where highly-coloured sands showing over 2 per cent. peroxide of iron and nearly 1 per cent. of lime have fused pure white, possessing all the characteristics for glass manufacture.

It is considered by some to be economical to show a decrease in expenditure by using very cheap grades of moulding materials, some large founders using building sands. This is a great mistake. There is, however, a considerable difference between using large quantities of old sand for purposes of economy, if the sand used was of the right character originally, and using similar quantities of old sand possessing no individuality. In other words, old sand which originally had good qualities is a valuable material, and can be successfully used in large quantities over and over again with the proper ingredients in a facing mixture. An inferior new sand, however, when rendered old, tends not only to "frit" and thus retard venting, but also helps to flux the mixture in which it is used. The main point for consideration, therefore, when the question of sand treatment arises, is in obtaining a supply of materials possessing the highest physical and refractory qualities possible. This is not easily done, as the most superior moulding sands, fireclays, and refractory materials are not always the ones best known.

Before entering into constructive details of machinery used for preparing and mixing moulding sands or materials, it would probably be as well to investigate the reasons why a facing-sand mixture should be mixed and treated. It is obvious that if it is necessary to employ different materials in a facing-sand mixture, then the whole bulk should be rendered perfectly homogeneous. Most founders will agree that it is necessary to use old sand, coal or coke dust, compositions, and other organic matter with a second new sand for facing purposes (except in certain cases); also that the ingredients must be correctly selected, accurately proportioned, evenly mixed and cut over, and finally tempered to the strength required. There is no disguising the fact, however, that many founders face their moulds with inferior new sand (in some cases building sand) which has had no treatment, and contains neither coal dust nor organic matter. Recognising the fact that coke and coal dust, organic matter and old sand are usually necessary ingredients to employ in a facing mixture, the questions of quality and quantity of such materials next arises. The quality of a coal dust necessary in a green-sand facing mixture is a matter of some little importance, though not so vital as that of the old sand. Since coal dust may be termed one of the principal ingredients in a facing-sand mixture for iron castings, it will not be out of place here to give the possible limit of its variation. The composition of coals from which the dust is made varies largely, not only in respect of the relative proportions of carbon, hydrogen, oxygen and nitrogen, but also in the amount of mineral matters which remain after combustion, as ash or clinker. This percentage of ash ranges from 1 to 35 per cent., and in some coals too poor to market even more than this amount. The ash consists chiefly of silica, alumina silicate, lime, magnesia, potash and soda, sulphur, with variable amounts of iron oxide and sometimes traces of lead and copper. The composition of coal ash closely resembles that of shales and fireclays, which usually are found either a strata above or below the coal, or in the "partings," *i.e.*, between the several layers of coal itself. The following table gives the composition of coal, shale, and clay ashes:—

Table showing Composition of Ash in Coal, Shale and Clay.

—	Newcastle Coal.	Scotch Coal.	Welsh Coal.	Blue shale clay.	Bituminous shale.	Newcastle F.C.
Silica (after deducting H_2SO_4)	62.44	49.63	42.67	58.99	60.31	57.08
Alumina	31.22	38.21		26.19	29.85	35.02
Sesquioxide of iron	2.26	—	43.56	—	3.14	5.17
Lime	0.75	3.18	0.65	—	2.19	1.63
Magnesia	0.85	1.41	1.08	0.67	1.83	1.73
Soda	—	—	—	2.34	2.12	—
Potash	2.48	—	—	1.54		—
Sulphuric acid (anhydrous) ...	—	6.26	4.46	—	0.69	—
Phosphoric acid (anhydrous) ...	—	1.03	0.66	—	—	—
Fe_2O_3	—	—	—	10.25	—	—

Some writers state that they have used coal dust containing ash as high as 34 per cent., but this would appear a much magnified case. Other founders express their intention of not using a coal dust unless the ash content is as low as 2.5 per cent. Both these figures, however, appear to be extreme points of variation, only occasionally met with in practice. Coal dust for use in facing-sand mixtures, however, should be selected, as far as possible, showing the following figures:—Ash, not over 3.50 per cent.; volatile matter, about 38.50 per cent.; fixed carbon, about 58.00 per cent. The coal should be ground in a ball or other suitable mill of enclosed type to prevent escape of dust, the resultant product being finally graded by sieving to suit different weights of castings. The proportions in which coal dust can be mixed with sand range from 1 to 6 up to 1 to 20, one to six being as strong as a mixture will stand so as not to cause veining in the casting. For light grey-iron castings under ¾ in. thick in section, coal dust is seldom used. The following scale may be taken to represent the proportions of coal dust to sand in proportion to thickness of section of the casting:—

	Coal dust.	Sand.
Castings ¾ in. up to 1½ in. in section	1	10
Castings 1½ in. up to 2½ in. in section	1	8
Castings over 2½ in. in section ...	1	6 or 7

Different authorities prescribe different proportions of coal dust to sand, but the exact adjustment of such proportions is a matter for local consideration only, as it would be impossible to recommend the exact proportions of any ingredient in a mixture without first examining the sands intended for use, beside the prospective work to be cast. When mixing facing-sand it should be remembered that it is not always the thickness of the casting which defines the strength of a mixture. Other things have also to be taken into consideration, viz., whether the casting requires pouring hot or dull, the distance of the most remote parts of the casting from its gate, and the time taken to fill the mould. Often solid, heavy castings are rendered

"cold shut" by using facing sand weak in proportion to the thickness of the casting. If old sand is used in a facing mixture, less coal dust will be required. The following mixtures for different classes of work will suffice to show a few practical examples of the proportions of coal dust to use:—

For Making Large Bevel Wheels in Dry Sand.

Parts.
100 new red moulding sand (medium strength).
100 new yellow moulding sand (weak).
10 silica sand.
1 to 16 coal dust. Wet with clay wash.

A Good Dry-Sand Mixture for Cylinders.

Parts.
400 new yellow moulding sand.
100 sharp sand.
36 coal dust.
Wet with fireclay wash according to consistency of loam.

For Brass Castings.

Parts.
16 old sand.
8 new red sand.
1 to 16 coal dust.
This mixture should be faced with pure Ceylon plumbago.

In many foundries a batch of new sand is thrown on the top of an old sand heap, coal dust added by guess, and the whole either "cut over" with shovels or put through a centrifugal mill without regard to proportions of ingredients used or "temper" of the finished product. The above method never ensures a uniform mixture which can be obtained and duplicated from day to day.

It is obvious that old floor or black sand, if of the right quality, is a useful ingredient in all sand mixtures, but the amounts in which such material can be used depend upon its quality and also the quality of the new sand. Some foundry floors are composed of sands possessing greater strength than others, while the old sand in floors in not a few foundries is often much too weak, "fritted," and dirty, besides being impregnated with free metallic oxides, to allow of its re-use. Different foundries, of course, follow different practices as regards their foundry floors, but the wiser course is to use only one sand, keeping the floor in good condition by adding to it a fresh supply of strong new sand, or, better still, a mixture made up by kneading a strong new sand into the body of an old sand by special machinery.

Some foundrymen must have long since realised the value of perfectly-mixed and treated sand mixtures; also that such mixtures produce better castings with smaller losses than those mixtures made up by hand. Not only is the cost of hand-prepared sand very high, but the product of such hand labour often very unsatisfactory. A few founders maw perhaps base their objections to sand-treating machinery on the reason of intangible profit of such machinery, taking up the position that their castings cannot be improved. A few manufacturing concerns may possibly enjoy a monopoly for the sale of their castings, and by getting high prices can allow a good margin of expenditure in the foundry. As far, however, as the external quality of finished castings is concerned, there is little doubt that mechanically-mixed and tempered sand mixtures will produce castings of a quality far better than if the sand is prepared by hand. It was often thought that a good skin possessing a nice blue sheen on a casting was quite unnecessary except for, say, special work; but such a skin protects the metal and aids in resisting the weather, etc., when the castings are exposed. Railway companies are now demanding chairs which possess clean blue skins, in order to avoid undue crystallisation due to exposure to the weather. The expense of obtaining mechanically-treated sand mixtures therefore proves more economical than hand-prepared facings, besides ensuring good skins to all castings.

Perhaps the first point a founder should decide when considering the question of mechanically mixing and treating moulding materials is the room he can spare, not only for the necessary machinery, but also for storing both raw and treated sands. He should be influenced when selecting the necessary site and room by the whereabouts of his present sand stores, as it would be unwise to erect mixing machinery any distance from the sand stores. If the present site of the sand store does not allow room for the necessary machinery, then a fresh site possessing a larger area must be selected. All sand stores should if possible adjoin a railway track or canal front, so that the sand can be dumped from railway wagon into store. In the case of a canal being alongside the foundry, sand can be transported by horse and cart, though the latter is a somewhat expensive process.

Having selected a site with room for the machinery and sands necessary, previously taking into consideration how much sand or other materials it may be required to accommodate at one time, the founder must then determine the maximum number of sand mixtures necessary to cope with his particular class of work successfully. These mixtures may come under the following headings:—(A) Dry-sand mixtures. (B) Green-sand mixtures. (C) Loam mixtures. (D) Core-sand mixtures.

Each of the above headings requires to be subdivided into further groups suitable for different classes of work. The mixing and treating machinery therefore should be capable of preparing any mixture, as enumerated, besides being able to prepare further mixtures as regards strength or temper which would come under each of the above headings.

In most foundries the total number of mixtures required will perhaps represent eight, each mixture being made up of different proportions of similar materials and possessing different strengths or tempers. The mixing machinery therefore must be adaptable to meet any of these requirements at frequent intervals. The largest individual material perhaps used in sand mixtures in most foundries is old sand, which will be referred to first. Old sand being distributed in all parts of a foundry floor makes it necessary that some practical and inexpensive means be provided for transporting this material to the machine for treatment. Conveyors or endless belts with elevators or other similar mechanical devices may perhaps be successfully applied in a brass foundry, or in an iron foundry making exclusively one type of casting, but owing to the greatly diversified character of work going on in large steel, iron or malleable-foundry floors, such an arrangement would be scarcely possible. A very simple, inexpensive and easily manipulated means of transporting old sand is by the use of side-tipping V-shaped trucks of about 12 to 16 cubic feet capacity, running on either 18 in. or 24 in. gauge tracks. Not only are many foundries already equipped with tramway tracks of the above dimensions, but the work of removing old sand by this method is easily carried out, and can be undertaken at night when the lines are clear. By adopting the V-shape of side-tipping truck, the latter can be instantly emptied of its contents into conveniently-arranged hoppers situate at the sand-treating

machine, which thus saves handling the sand twice. A convenient form of truck is shown in Fig. 1, as made by Messrs. McLachlan & Company, Limited, Haughton Bridge Wagon Works, Darlington. The foundry should, therefore, if unprovided, be equipped with tracks to enable trucks to pass to and from foundry floor to treating and mixing plant.

On the site allocated to sand storage several separate bins should be constructed, the outside walls of which should be fitted with sliding doors, facing railway lines or canal front so as to facilitate the entry of a railway wagon or Scotch cart, from which the new sands may be dumped into the centre or end of the bins. Each bin should be so built that it will communicate with its fellow by small doorways, yet so arranged that the different new sands do not become mixed. It is as well to have the walls of sand bins built of brickwork, which not only acts as a support for the sand, enabling larger quantities to be stored, but also provides support for a suitable roof. Founders should

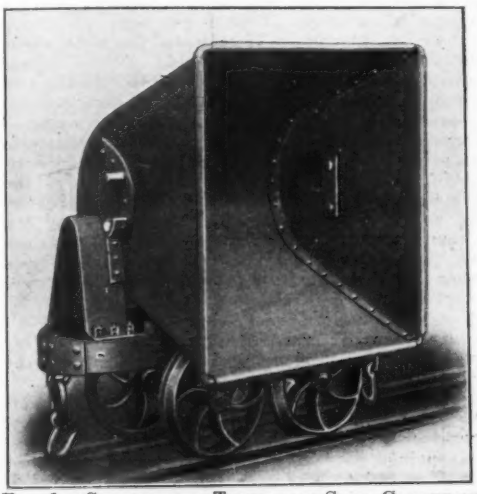


FIG. 1.—SIDE-TIPPING TRUCK FOR SAND CONVEYANCE.

always make a practice of keeping their sands under cover, and never use fresh, wet sand, which is a dangerous material to employ at any time in a mould. It is far better to keep moulding sands, loam, and fireclay several months preparatory to using, than use same straight out of the truck or barge, especially as some sands contain as much as 30 per cent. by weight of moisture. The founder should also requisition his supply of sands in the summer months, when they will be in a much drier condition than if supplied between January and April or October and January. The difference in weight between wet and dry sand is a great deal, and in the course of a year represents a considerable sum, not only in the cost of the sand used, but also in the matter of carriage. Also it is better for the sand to be drying at the quarry owner's expense than at the founder's.

(To be Continued.)

VANADIUM-STEEL DIES.—Vanadium-steel dies for punching sheet steel are being used in the United States. In the case of gaskets made from unpickled sheets 0.007 in. in thickness, the best production which could formerly be secured from ordinary tool-steel dies without re-grinding was 40,000 punchings. Vanadium steel dies gave 90,000 punchings.

National Physical Labatory.

The annual inspection of the National Physical Laboratory by the Genral Board was made on Friday, June 19, when the various departments were thrown open to a large gathering of visitors. In the afternoon the annual meeting of the General Board was held, Sir William Crookes, President of the Royal Society and Chairman of the Board, presiding, supported by Lord Rayleigh, F.R.S., Dr Schuster, F.R.S., Sir A. B. Kempe, F.R.S., and Dr. R. T. Glazebrook, F.R.S. The report and accounts for the year 1913-14 were presented and approved. In the report attention was drawn particularly to the great growth in the work of the laboratory since its opening in 1901, and to the large financial liability now incurred by the Royal Society in its management. Of the £44,000 constituting the total income of the Laboratory, the greater part is in the form of payment for work done, the Government grant-in-aid amounting only to £7,000. It is pointed out in the report that the technical societies and institutions represented on the General Board have urged that, while it is desirable that the control of the institution should remain in the hands of the Royal Society, it is necessary for the proper development of the Laboratory that increased Government support should be given, and that steps should be taken to free the Royal Society from the serious financial difficulties that would arise in the event of a falling off in any year in the receipts for work done, and from the necessity of finding the working capital. The matter is now under consideration by the President and Council of the Royal Society with a view to the Government being approached. Of the changes made during the past year, the most important is the transference to Teddington of the testing of instruments formerly corried out at Kew. During the past year a new department for the testing of radium preparations has been established and placed under the control of Dr. Kaye.

POWER: ITS ECONOMICAL DISTRIBUTION.—The British Aluminium Company, Limited, of 109, Queen Victoria Street, E.C., have just issued a very well illustrated and interesting pamphlet under the above title. The question of the cost of aluminium as compared with copper cables is fully considered, and instances are given showing the economy of aluminium. The book should be in the hands of all those who have to do with the purchase or use of electric cables.

SOCIETY OF CHEMICAL INDUSTRY.—The annual general meeting of the Society of Chemical Industry will be held in Nottingham on July 15, 16, and 17, under the presidency of Dr. Rudolph Messel, F.R.S. The programme is:—*Wednesday, July* 15.—Morning: Annual general meeting to be held at University College; addresses of President and Sir Wm. Crookes, O.M., Pres. R.S.; presentation of Society's Medal to the Rt. Hon. Sir Henry E. Roscoe, LL.D., F.R.S. Afternoon: Luncheon at the Victoria Station Hotel, by invitation of the Nottingham Section; visit to Southwell and garden party at Brackenhurst Hall, by invitation of the High Sheriff of Notts., Mr. W. N. Hicking, J.P. Evening: Reception at the Castle by his Worship the Mayor of Nottingham. *Thursday, July* 16.—Morning: Excursion to works at Derby and Nottingham. Afternoon: Garden party at Gedling House, by invitation of the chairman of the Section, Sir John Turney. Evening: Annual dinner of the Society at the Exchange Hall. *Friday, July* 17.—Whole day excursion to the Dukeries (by motor char-á-banc). Evening: Reception by Sir Jesse Boot at "Plaisunce."

Ferro-Chrome in the Manufacture of Steel.

Ferro-chrome has been made by four different processes, involving the use of:—(*a*) Coke-fired crucible furnaces; (*b*) blast furnaces; (*c*) electric furnaces; and (*d*) the Thermit or Goldschmidt process.

Ferro-chrome was, in the first instance, made in crucibles. Chrome iron-ore, previously powdered, was mixed with 6 per cent. to 8 per cent. of carbon in the form of charcoal or anthracite. This mixture was melted in graphite or magnesia crucibles by aid of such fluxes as alkaline fluorides mixed with lime, borax mixed with carbonates, bottle-glass, etc., and raised to a high temperature.

Later these alloys were produced in blast furnaces, in the form of chrome pig-iron. The limit reached in chromium content is usually 30 per cent. to 40 per cent., although some containing up to 60 per cent. have been made. The process differs but slightly from that by which ordinary pig-iron or silicon pig-iron is produced. A very large consumption of fuel is required—about three tons of coke per ton of 40 per cent. chromium alloy. Also the ferro-chromium is usually high in combined carbon, and is apt to contain sulphur unless special precautions are taken.

Most rich ferro-chromes are made in the electric furnace by direct reduction of chrome iron ore with carbon, coke or charcoal, the heat of fusion being furnished by the electric current. The composition of this ore varies greatly according to the source of supply. For that used in the electric furnace an average composition would be:—Cr_2O_3 50 per cent.; FeO 25 per cent.; Al_2O_3 10 per cent.; lime, silica, magnesia, etc., variable. It is found in Scotland, France, Eastern Europe, Asia Minor and New Caledonia; deposits occur also in the United States and New South Wales.

The electric furnace was not used for production commercially until about 1892, some time before ferro-silicon was so made. The arc is produced between electrodes usually outside the bath, to prevent re-carburisation. The usual mixture for the charge is:—Chrome iron-ore (50 per cent. Cr_2O_3), 100 parts; coke or anthracite, 21 parts. With this a ferro-chrome containing 60 per cent. to 64 per cent. Cr, and about 9 per cent. carbon will be produced. To refine this alloy it is crushed and placed in a bed of the following composition, viz.:—Crushed ore 14 parts, lime 2 parts, for every 100 parts of alloy to be refined. By repeating the operation several times, 4 per cent. carbon ferro-chrome is obtained, but to attain this, furnaces containing no trace of carbon must be used.

To obtain ferro-chromes with less than 4 per cent. carbon, M. Guillet says, "methods which are kept absolutely secret must be employed. To such a point is secrecy preserved, that at the Giffre factories the furnaces in which these are made are surrounded by high walls."

The Goldschmidt or Thermit process is one of direct reduction, depending upon the powerful affinity of aluminium for oxygen, whereby it is able to combine with the oxygen of chromic oxide, leaving the chromium in a free state. The re-action may be represented thus:—$Cr_2O_3 + 2Al = 2Cr + Al_2O_3$. The heat produced is so great that methods have to be adopted of controlling the re-action. The usual procedure is as follows:—Molecular parts, 15.28 Cr_2O_3 and 5.42 Al, are mixed in a well-dried crucible lined with magnesia calcined at a not too high temperature. On the top of the mixture is placed a small heap of an ignition powder made by mixing powdered aluminium with an easily reducible oxide such as barium or sodium oxide; and into this heap is inserted a short piece of magnesium wire or cordite. The ignition of the magnesium wire, or the cordite, is sufficient to start the re-action in the ignition powder, which is then communicated to the mixture in the crucible. When the re-action is fairly started, the remainder of the chromic oxide and iron mixed with the requisite amount of aluminium are slowly charged into the crucible. The reduced alloy settles to the bottom of the crucible, under a layer of slag consisting of fused alumina. This process has been used at Essen for the manufacture of ferro-alloys.

Functions of Ferro-Chrome in Steel Manufacture.

Chromium as a constituent of steel confers important physical properties. For steels low in carbon, those containing less than 7 per cent. Cr are pearlitic in structure; from 7 per cent. to 15 per cent. Cr Martensite or Troostite is the main structure; above 15 per cent. Cr double carbides appear as small particles, white and very hard. As the proportion of carbide content increases, so these changes of structure occur with smaller percentages of chromium. Thus with 0.8 per cent. C the passage to Martensitic steel takes place at about 5 per cent. Cr. Of these steels the pearlitic alone are of any industrial value. Those containing the double carbide are too brittle and too hard, offering but medium resistance to shock. The pearlitic steels are hard, the hardness increasing rapidly with the proportion of chromium; they exhibit high resistance to rupture, and high elastic limit, giving elongation and reduced section equal to some ordinary steels, but are generally more brittle. Like all pearlitic steels, hardening produces Martensite, but of a very hard character.

Such chrome steels are mainly used for armour plate, armour-piercing projectiles, some high-speed steels, steel for stamps and crushers, also for files, tyres, springs, etc. But it is owing to the important controlling influence of other metals, such as nickel, tungsten, vanadium, etc., that most of them are made useful in the highest degree.

Chrome steels are prepared either in the open-hearth furnace, converter or crucible. The most convenient method of conveying the chromium into the bath is by means of a suitable ferro-chrome alloy. The alloy is added to the bath before tapping, or may be melted separately and run into the converter or ladle. Unlike ferro-silicon, none goes into the slag, and it exerts no deoxidising influence on the occluded gases in the molten metal. As to the most suitable ferro-chrome to be employed, this depends on the composition required for the final product in carbon and chromium. The cheaper ferro-chromes may contain nearly 10 per cent. of carbon, and consequently cannot be used when low-carbon steels are required, except under special conditions. High-carbon ferro-chromes (*i.e.*, over 6 per cent. carbon) are used mainly in projectiles (2 to 4 per cent. Cr.), and for stamps, crushers (0.5 to 1 per cent. Cr.), etc. Both high- and low-carbon ferro-chromes are used in armour plate (about 2 per cent. Cr.) and in special steels; mostly high-carbon for the former, but low-carbon for the latter. For high-speed steels, low-carbon ferro-chrome is almost invariably used, and is added in the crucible. Chrome steel for files contains 0.5 per cent. to 0.7 per cent. carbon and 2 to 3 per cent. chromium, the higher percentages giving extremely hard tools.

Employment of Coke-Oven Gas in Steel-Making.*

By O. Simmersbach.

Previous experience in the use of coke-oven gas in open-hearth furnaces has shown that pre-heating the gas is attended with decomposition and a loss in the heating value. In the case of producer gas the decomposition only lowers the heating value by about 4 per cent., which is practically negligible; but in using a mixture of blast-furnace and coke-oven gases the loss may amount to as much as 13 per cent. With coke-oven gas, used alone, it has been found that a gas with an initial heating value of 4,560 cal. suffers a loss of heating power to the extent of 13 per cent. when pre-heated to 900 deg. C., the loss increasing to 14 per cent. on pre-heating to 1,000 deg. C., and to as much as 28 per cent. at a temperature of 1,065 deg. C. (Table I.).

TABLE I.—*Analyses of Coke-Oven Gas.*

I.		II.		III.		IV.	
Initial composition.	After heating to 900° C.	Initial composition.	After heating to 1000° C.	Initial composition.	After heating to 1065° C.	Initial composition.	After heating to 1065° C.
Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.	Per cent.
CO_2 3.4	CO_2 2.8	CO_2 2.8	CO_2 3.8	CO_2 2.4	CO_2 3.2	CO_2 2.6	CO_2 2.6
CO 5.6	CO 6.0	CO 7.4	CO 8.4	C_nH_m 2.0	C_nH_m 0.2	C_nH_m 2.0	C_nH_m 0.6
H 47.7	H_2 43.5	H_2 44.7	H_2 43.6	CO 4.2	CO 9.6	CO 5.0	CO 8.8
CH_4 30.3	CH_4 25.3	CH_4 29.9	CH_4 23.3	H_2 51.1	H_2 35.7	H_2 49.9	H_2 35.2
—	—	—	—	CH_4 30.2	CH_4 20.5	CH_4 30.1	CH_4 18.7
Heat units 4560	Heat units 3950	Heat units 4450	Heat units 3820	Heat units 4580	Heat units 3400	Heat units 4560	Heat units 3300
Decrease in heating value 13%.		Decrease in heating value 14%.		Decrease in heating value 26%		Decrease in heating value 28%.	

Decomposition begins to be appreciable at about 700 deg. C., as may be gathered from Table II., which was compiled from experiments made at the Friedenshütte Works. In this case also, heating the gas to 1,000-1,060 deg. C resulted in a loss of approximately 24 per cent. of the heating value (Table III.). Since the kinds of coke-oven gas used at the various temperatures in these experiments were not identical, the results were not of a comparable nature, and therefore other tests were made by passing one and the same gas over heated firebrick at increasing temperatures, the firebrick being exposed to oxygen after each test. The changes in composition are shown in Table IV., and the alterations in heating value in Fig. 1. The fall in heating power amounted at 800 deg. C. to 2-6 per cent.; at 900 deg. C. to a further 6-13 per cent.; at 1,000 deg. C. to an additional 3-7 per cent.; at 1,100 deg. C. to another 2-9 per cent., and on exceeding 1,200 deg. C. to an additional 14 per cent., the total loss sustained by heating to 1,200 deg. C., being about one-third of the total initial heating value. The curve relating to Series I. (Fig. 1) gives the results obtained when the carbon resulting from the dissociation of the gas was allowed to remain on the firebrick, whilst that for Series II. shows the effect of burning off this carbon between successive tests. A comparison of the effect of the two methods on the composition of the gas when heated to 1,200 deg. C. gives the following result :—

	Series I. Per cent.	Series II. Per cent.
Increase in hydrogen ..	75	78
Increase in carbon monoxide	50	129
Decrease in methane ..	77	83
Decrease in carbon dioxide	100	100
Decrease in heavy hydrocarbons	100	100

The chief feature in the reactions set up by heating the gas is the decomposition of the hydro-

TABLE II.—*Analyses of Coke-oven Gas before Heating.*

Sample.	Heating temperature. °C.	CO_2 Vol. %	C_nH_m Vol. %	O_2 Vol. %	CO Vol. %	H_2 Vol. %	CH_4 Vol. %	N_2 Vol. %
1..		5.0	1.6	0.6	10.8	49.2	21.3	11.5
2..		5.0	1.4	0.4	11.2	43.8	24.6	13.6
3..		4.4	0.8	1.2	11.4	54.7	16.4	11.1
4..		4.0	1.4	1.2	11.4	54.8	16.4	10.8
5..		5.2	1.4	1.0	11.0	48.8	19.5	13.1
6..		5.6	1.4	0.6	10.0	45.0	19.8	17.6
	After heating.							
1..	750—760	4.0	0.8	0.6	12.6	50.2	20.5	11.3
2..	800	3.0	0.3	0.4	13.3	45.2	23.2	14.6
3..	900—940	3.0	0	0	14.8	58.6	11.4	12.2
4..	900—940	1.6	0	0	20.0	58.5	7.8	12.1
5..	1000—1040	1.2	0	0	19.8	52.6	12.6	13.8
6..	1000—1060	0.4	0	0	19.2	60.0	4.8	15.6

TABLE III.—*Changes in Heating Value of 1 Cubic Metre (35.3 Cub. Ft.) of Coke-oven Gas.*

Sample.	Heating temperature.	Value before Heating. Heat-producing constituents.				Heating value of gas.	Decrease in heating value.	
	°C.	CH_4 heat units.	CO heat units.	H_2 heat units.	C_nH_m heat units.	Heat units.	Absolute heat units.	%
1..		1,837	330	1,272	227	3,666		
2..		2,123	343	1,134	199	3,799		
3..		1,413	349	1,416	113	3,291		
4..		1,413	346	1,420	199	3,381		
5..		1,680	337	1,263	199	3,479		
6..		1,708	306	1,165	199	3,378		
		After Heating.						
1..	750—760	1,766	385	1,300	113	3,564	102	2.8
2..	800	2,000	407	1,172	43	3,682	177	4.67
3..	900—940	985	453	1,517	—	2,945	346	10.8
4..	900—940	673	612	1,513	—	2,798	583	17.2
5..	1000—1040	1,087	607	1,362	—	3,056	423	12.15
6..	1000—1060	414	588	1,582	—	2,584	794	23.6

* Stahl und Eisen.

carbons, which give off carbon, this in turn uniting with oxygen to form carbon-monoxide or dioxide, and also with the last-named to form monoxide. The hydrocarbons also react with other gases, Lang having found that in a mixture of methane and carbon dioxide, heating to 950-1,054 deg. C. reduced the percentage of carbon dioxide from 29.4-33.3 per cent. to 20.1-26.8 per cent., with formation of 8.2-6.4 per cent. of carbon monoxide.

TABLE IV.—*Change in Percentage Composition of Gas (Vol. per cent.).*

Composition before heating.	Temperature °C.	800	900	1,000	1,100	1,220
	Duration of heating seconds.	14	11	12	13	14
3.4	CO_2	2.1	1.3	1.0	0.7	0.2
0.9	O_2	0.5	0.3	0.2	0.2	0.1
6.3	CO	11.0	12.0	12.9	13.5	14.4
2.7	$C_n H_m$	2.0	0.2	0.1	0.0	0.0
33.2	CH_4	27.6	20.2	17.3	15.6	5.5
42.6		48.6	58.8	63.7	66.1	75.7

It may therefore be safely assumed that when coke-oven gas is pre-heated in the gas chambers of modern open-hearth steel furnaces, the heating value of the gas will be reduced by one-fourth to one-third. This is naturally accompanied by an increase in the volume, and therefore in the velocity of the gas, with the result that the combustion of the gas takes place more in the chambers or heads than in the furnace itself. Moreover, as the result of leakiness in the heating chambers, the percentage of nitrogen increases to an even greater extent than the volume of the gas itself.

If it be desired to utilise the waste heat of the products of combustion for pre-heating the gas, the gas chambers can be reduced in size, and the gas

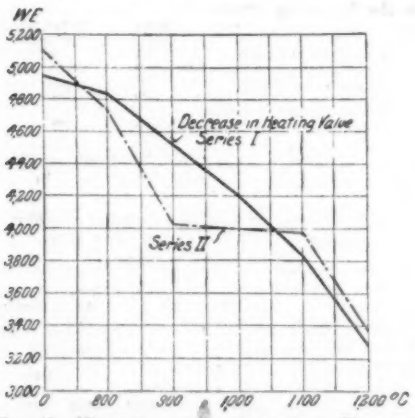


FIG. 1.—CURVES OF ALTERATION IN HEATING VALUE.

heated up to 500 deg. C., or 700 deg. C., at the outside, because at the former temperature the changes in composition and heating value are reduced to a minimum. Bearing in mind, however, that pre-heating to either of these temperatures merely raises the heating power of the gas, per unit volume, to an extent which almost exactly balances the loss of heating value by the decompositions produced at those temperatures; and also taking into consideration the fact that the temperature obtained from the combustion of cold coke-oven gas in heated air is sufficiently high for steel-making; it will be evident that no special advantage can accrue from preheating the gas, even to the temperatures last mentioned.

During the last four years good results have been obtained in the steel foundry at the Cockerill Works, Seraing, with open-hearth furnaces holding 4 to 7 tons fired with cold coke-oven gas introduced from the one end only; and recently the system has been extended to a 12½-ton basic open-hearth furnace. The gas has a heating value of 3,640 cal., and the consumption of gas per ton of steel is 11,470 cub. ft., as compared with 10,600 cub. ft. of producer gas, the output of the furnace being, however, 25 per cent. greater. A similar experience with an acid open-hearth furnace of the same capacity, using heated gas (the output being increased by about 15 per cent.), has been obtained at the Friedrich-Wilhelmshütte Works; and also with larger furnaces (40 to 85 tons) in America.

Given suitable furnace construction and of large size, there is no reason to doubt that the consumption of coke-oven gas of good quality can be reduced to 8,000 cub. ft., or even 7,000 cub. ft., per ton of steel, especially when it is remembered that the coal consumption in producer-gas firing depends on the regularity with which the gas is supplied. The economy of consumption in the case of coke-oven gas, however, is mainly due to the fact that the temperature of the flame in the open-hearth furnace is about 100 deg. C. higher than that furnished by producer gas, so that less time is required for melting the scrap and refining the iron. At the same time a better intermixing of the bath is obtained in the early stages of working the charge, the higher temperature facilitating the combustion of the carbon in the metal, whilst there is more efficient transmission of heat from the hotter flame to the bath. On the other hand, when the bath is in a more even state of flow, during the final stages, the transmission of heat proceeds by conduction alone, the hottest metal floating at the top, so that the higher temperature furnished by coke-oven gas shortens the working process, and is particularly valuable in view of the greater heat required to keep the metal liquid in proportion as carbon is eliminated. Again, the heat-absorption capacity of the bath varies at different stages of the process, and whilst it is difficult to modify the composition of producer gas accordingly, regulation is easy in the case of coke-oven gas, thus saving time and fuel and reducing heat losses by radiation.

Apart from the loss of about 33 per cent. of calorific value by pre-heating coke-oven gas, it is desirable, in the open-hearth furnace, to generate a flame with a large amount of radiant heat, so that the heating effect is produced, not so much by direct contact as by radiation on to the bath and the furnace walls. For this, free carbon is necessary; and in the case of cold coke-oven gas, the dissociation of the hydrocarbons liberates numerous particles of free carbon which are raised to the same temperature as the flame and emit much light and heat. This ensures better transmission of heat to the bath, particularly since the separated carbon provides for the formation of a flame with extensive heat radiation in the second half of the furnace as well. This is highly important, because in the new 100-ton open-hearth furnaces, with a hearth about 40 ft. in length, it is necessary to bring the charge into uniform ebullition over the full length of the hearth.

The hydrogen flame itself is barely visible, and therefore the higher the percentage of hydrogen in the gas, the shorter and hotter the flame. Since pre-heating increases the proportion of free hydrogen

in coke-oven gas by about 75 per cent., the cold gas gives a longer flame, extending further along the furnace. With pre-heated gas, losses are sustained during reversal, since all the gas between the hearth and the reversing valve is obliged to return to the valve, and also because direct communication is set up between the gas main and the chimney stack while the valve is being reversed—which losses are not incurred when cold gas is used. Moreover, since less time is taken up in reversing the flow of gas in the chambers and passages, the supply of flame to the furnace is not suspended, and the flame does not act direct on the arch for so long a time. Again, in the case of cold gas, the reversing valves are not exposed to an injurious temperature, and there is no risk of explosion during the actual reversing.

In comparison with producer gas, there is a not inconsiderable saving in the cost of labour, owing to the absence of any deposition of dust and tar in the mains, passages and valves, and the consequent interruptions in working. There are also no changes in the sectional dimensions of the gas mains, with their attendant ill effects on the capacity and safety of the furnace. The old fear that heating with coke-oven gas would corrode the furnace arch more seriously than producer gas has proved unfounded, the flame being really kept more effectually from contact with the arch by the fact of the lower density of the hot air and the large amount of such air needed for combustion.

The quality of the steel is also improved by the use of coke-oven gas, because this gas is poorer in sulphur than many kinds of producer gas; and in respect, too, of hydrogen content no injury to the quality of the steel has yet been found to result, in practice, from the use of coke-oven gas, either alone or mixed with blast-furnace gas.

Against these advantages must be set the drawback that, in the present type of open-hearth furnaces using cold coke-oven gas as fuel, the products of combustion are removed solely through the high-lying air flues, and no longer through the gas flues situated immediately over the bath. This is the more serious in the large furnaces, in which the hearth is 35-40 ft. long, the gases escaping through the flue immediately under the arch in the second half of the furnace, being diverted from the surface of the bath, with the result that this portion of the bath takes much longer to heat up and finish off. This drawback can, however, be remedied by the arrangement shown in Fig. 2, in which the air of combustion is admitted through the auxiliary air ports adjoining the gas port, in addition to the usual air ports at the top, the two sets of air ports being connected together. In this way the waste gases are enabled to escape through the lower air ports on the exhaust side, so that the flame remains close to the surface of the bath.

In consequence of the provision of these auxiliary lateral air ports, the current of gas is surrounded by air at the sides as well as above, thus ensuring more intimate admixture of the gas and air, and producing, directly above the bath, a powerfully oxidising flame which melts and refines the charge quickly. The great importance of properly mixing the gas and air will be evident from the fact that, in furnaces working with pre-heated gas, i.e., gas chambers, the products of combustion drawn off through the upper air flues contain a large excess of oxygen, whereas those drawn off through the lower gas ports are deficient in oxygen. On the other hand, when the gas and air are intimately mixed, a no less rapid and comparatively complete combustion is obtained, so that the gas is entirely consumed in the furnace and does not escape unconsumed into the opposite head; moreover, the flame extends far into the chamber and even into the reversing valve, a danger which the end walls and heads of the furnace could not withstand for long.

Whereas when pre-heated coke-oven or producer gas is used the point at which the gas and air meet above the bath continually recedes, and it becomes increasingly difficult to keep the exhaust side of the hearth properly heated, this retrogression is far less noticeable when cold gas is used. Consequently, the furnace works more uniformly and is more easily kept hot at the exhaust side.

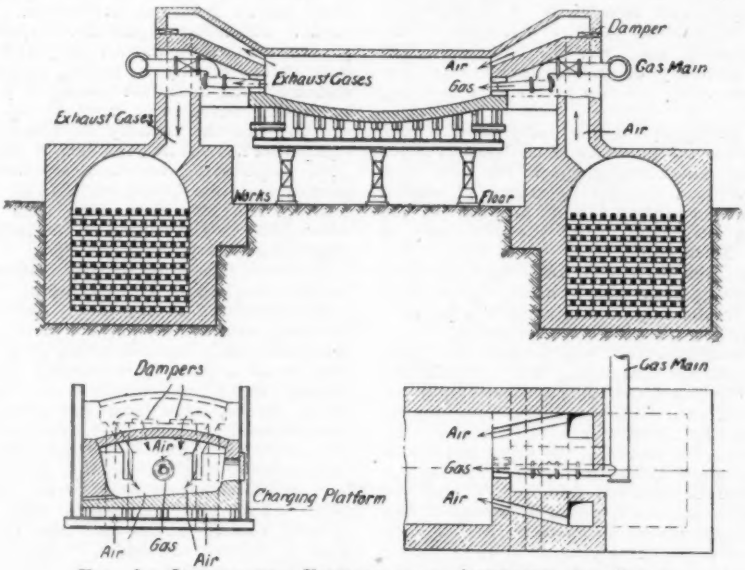


FIG. 2.—OPEN-HEARTH FURNACE WITH AUXILIARY AIR PORTS.

Visit to the Sheepbridge Works.

Staffordshire Iron and Steel Institute.

About seventy members of the Staffordshire Iron and Steel Institute, on Wednesday, June 24, paid a visit of inspection to the works of the Sheepbridge Coal and Iron Company, Limited. The visitors included Mr. J. Raybould (President), Mr. Ernst Fletcher (Vice-President), Messrs. R. Buchanan, R. Edwards, and H. Silvester (Past-Presidents), J. Piper (Treasurer), A. Home Morton, E. E. Roberts and W. H. Carder (Secretary).

On reaching Chesterfield the party lunched at the Angel Hotel, and re-entering the special saloons were conveyed by Midland Railway into the works at Sheepbridge, where they were received on behalf of the firm by Mr. Herbert Pilkington (works manager), with whom were Mr. E. Houghton (blast-furnace manager), and Messrs. W. I. Peach (mill manager), J. T. Goodwin (foundry manager), A. E. Meridith (engineer), and Mr. J. McKinn. The directors and secretary of the Company were prevented from attending through a directors' meeting in London.

After being photographed, the party made a tour of the works under the guidance of the various heads of departments. The Sheepbridge Works have been considerably extended and greatly improved, especially in mechanical equipment, since the visit of the Iron and Steel Institute, during the presidency of the Duke of Devonshire, four years ago. The foundries have been extended and enlarged, new departments having been added, while a great deal has been done in the way of electrification, particularly in connection with auxiliary machinery.

Among the most important additions to the works are the pipe foundries comprising No. 1, No. 2 and No. 3 shops. The two first-named are each equipped with two casting pits. The former is laid out to produce 3-in. to 12-in. socket or flange pipes in 9 ft. to 12 ft. lengths. For handling the pipes and tackle there are two five-ton hydraulic cranes. The shop is furnished with eight gas-fired stoves for drying the cores, the latter being manipulated by means of two seven-ton overhead travelling cranes. No. 2 shop deals with larger pipes, namely, 6-in. to 48-in. socket or flange pipes in 12 ft. lengths. The hydraulic crane in this shop is of 20 tons capacity, and there is a 10-ton overhead electric crane, in addition to stove equipment and electric lifting machinery of the same character as in No. 1 shop. Each has two cupolas with a capacity of 12 tons per hour to supply the requisite molten iron. No. 3 shop is devoted to the production of 3½-in. and 4-in. socket or flange pipes in No. 5 pit, and 1¼-in. to 6-in. diameter on banks. This shop is served by a 7-ton cupola, and has two 3-ton overhead electric cranes and six stoves for drying the cores and moulds. A feature of the casting arrangements is that all the pipes are produced with the socket downhill, a decided advantage, from the engineering point of view, inasmuch as all residual material can be got rid of without affecting the main body of the pipe. The enlargement of the capacity of the cupolas from 6 tons to 12 tons has been quite recently carried out. The latest and largest pit has practically trebled the firm's capacity for the production of 12-in pipes. At the present time, the foundries are making large outputs of material for the equipment of an extensive sewerage scheme in Buenos Aires. Another large order is for bolted tubbing for the Kent coalfields, and some tank plates of large size are being turned out.

The last-named products are being produced in the general foundries, which comprise two shops able to deal with general castings up to 50 tons weight, including colliery tubbings, tunnel lining plates, columns, tanks, girders, etc. These shops are well equipped with electric travelling cranes and jib cranes and the machine shops are proportionately large and well furnished. The foundry capacity comprises 30,000 tons in the pipe department, and 10,000 tons in the general shops. In the modernising of plant the general tendency is to supplant hydraulic apparatus by electrical, except for testing purposes.

Another recent addition is an extensive fettling shop, 150 ft. by 45 ft., served with a 30-ton overhead crane. The latest cupola has a special charging apparatus for dealing expeditiously with heavy material, and quite recently a testing apparatus has been added for the hydraulic testing of pipes of all sizes, subjecting them to a pressure up to 550 lbs. per sq. in. In the foundry department, the enlarged equipment has enabled the firm to enormously develop their engineering business, especially for the Admiralty and War Office, while a large amount of new business has been opened up with foreign Governments, and in the supply of the largest agricultural engine machinery.

The mills have been greatly modernised, especially in the direction of electrification. There are three mills comprising 20-in., 12-in., and 10-in. train and finishing rolls for strip. The 20-in. mill has lately been practically reconstructed, and within the past few weeks a pair of horizontal reversing engines, having steam cylinders 32 ins. in diameter and 42-in. stroke, have been brought into operation. The reversing is carried out with remarkable promptness and the engine works very efficiently. It was built entirely by the Company, also the new housings having electrically-operated screw gear for balanced rolls. This mill produces a wide range of flats, squares, rounds, angles and tees, in iron and steel, with a variety of wagon-building material. The other mills are steam driven, but a great deal has been done in the introduction of electrical saws, punches, and other auxiliary plant.

Special interest was taken in the testing shop where a 50-ton Buckton testing machine, with a lathe and milling machine for preparing test pieces has been installed. The testing of several short pieces of ¾ in. round bars was witnessed by the visitors. Electrical power has been introduced for machine driving in the pattern shop and in the machining and erecting shop. The latter department is served by an electric 10-ton overhead travelling crane.

The firm were among the first to introduce electricity for blowing and other purposes, and quite recently the earlier engines have been replaced by more modern machinery. The power station, generating electricity for power and light, generates a voltage of 230 direct current. The station contains two direct-coupled generators, driven by gas engines of 200 b.h.p. and 450 b.h.p. respectively, of the Westinghouse vertical tandem-cylinder type. The 200 b.h.p. gas engine has six cylinders and the 450 b.h.p. engine has eight cylinders. The gas engines are operated with blast-furnace gas, taken direct from the furnaces, and passed through a cleaning plant. A duplicate

450 b.h.p. gas engine set is being installed, and this will bring the total electrical supply up to 1,100 b.h.p. The hydraulic plant consists of two pairs of hydraulic engines. One of the differential type has a steam cylinder 18 in. diameter, 30 in. stroke, the other, of the bucket type, has steam cylinders 14 in. diameter, 18 in. stroke. The accumulators are loaded up to 7,000 lbs. per square inch and the power is used to work the hydraulic cranes and various testing machines for the proving of pipes before delivery.

In connection with the rolling mills it should be added that, in addition to the ordinary type, there are two new-form Siemens furnaces, one for the 10-in. mill, and the other for the 20-in. mill.

The blast-furnace plant comprises four furnaces, of which three are now in blast while the largest of the four, being 70 ft. high, is in readiness for blowing in, when the market demand justifies an increase of output. The total capacity of the furnaces is 85,000 to 95,000 tons per annum. There are four calcining kilns, eight Cowper stoves, and blast is produced from two beam engines, having steam cylinders 50 inches diameter, blowing cylinders 100 in. diameter and stroke 180 in. The kilns are automatically charged by a double incline and tilting skips, the same kind of apparatus being applied to the large furnaces, the tilting skips being served from bunkers and kilns by electric trolleys.

In the forge department there are 24 puddling furnaces and three scrap furnaces, and the various mills and hammers are driven by steam produced from waste blast-furnace gases.

In addition to showing commercial enterprise the Company have manifested a keen interest in the social welfare of their workpeople, in the laying out of playing fields, cricket fields, etc., near the works, the erection of a sports pavilion, etc., while an institution much prized by the workpeople is the Working-men's Institute near by, equipped with billiard rooms, reading rooms, etc., membership of which is obtainable by the payment of a nominal sum. A number of workpeople were taking advantage of these rooms at the time of the visit.

After leaving the works, the visitors were entertained to tea in the Institute by the Company. After tea, the President, Mr. Raybould proposed a hearty vote of thanks to the Directors of the Company, and the staff, who had done so much to make the visit instructive and enjoyable. The speaker acknowledged the kindness shown in throwing open the large and interesting establishment. The permission to visit was most promptly given, and those who had previously visited the works would see for themselves how great had been the enterprise shown in development during the past five or six years. It was an additional pleasure to come to Sheepbridge, because Mr. Pilkington himself was a Staffordshire man, and a past President of the Institute. The visitors would desire him to acknowledge the hospitality with which they had been treated by the Company, as well as the courtesy of the railway company in so great'y adding to their convenience by allowing them to ride direct to the works.

Mr. Fletcher, the Vice-President, in seconding the vote of thanks, said the members had seen and learnt a great deal in the course of the afternoon, for which they were very grateful to the Sheepbridge Company.

The vote was carried with acclamation.

Mr. Pilkington, responding, said that the visit had been a special pleasure to himself, because of his long personal connection with the Institute, and the many personal friendships he had formed with Staffordshire men. He felt bound to make every effort to make the visit pleasant and profitable. The visit was suggested some years ago, but had at that time to be postponed, because certain developments were in progress, and the Company preferred to wait until these were complete before showing the works. He was very grateful for the opportunity of meeting old and new friends, and the members would always be welcome at the Sheepbridge works.

The members afterwards entrained from the works to Chesterfield, where they joined the express to Birmingham, everyone being highly pleased with the visit, which had the additional advantage of favourable weather.

Small Steel Castings.

In the course of an address by Mr. C. S. Koch, president and general manager of the Fort Pitt Steel Casting Company, McKeesport, Pa., given before the Pittsburgh Foundrymen's Association, recently, the speaker said :—

The policies and methods here referred to do not pretend to represent general practice, but cover the principles which have been worked out by a more or less successful concern which specialises in the manufacture of small steel castings. Such castings may be defined as those which do not weigh over 50 lbs., with metal sections ranging from ⅛ in. down. Practically all of the steel poured into small castings is made by three methods, which include the side-blow converter process, the crucible furnace and the small open-hearth. As to the relative quality of the steels produced by the various methods, this is not a matter entirely of process, but of operators. It is not so much which process has made the best record in tensile tests, but which process day in and day out gives the most uniform results to the foundryman and to his customers. It is the writer's opinion that this desirable result is most often obtained by the converter, and also that the converter has the power to produce very easily low-carbon steels which show tests heretofore thought impossible by engineers. Proper annealing affects the quality of the metal to a greater degree than the usual variations in the steel in well-run foundries.

The moulding department in a plant which makes small steel castings successfully, differs greatly from that in an iron foundry and also from that in a steel foundry turning out large work. The difference lies in the foreman, the equipment, the moulder and the mental attitude of the whole organisation toward small work. Of these four, the latter is by far the most important, but perhaps the most difficult to see. Few, if any, successes have been made in small work by men and companies who specialised on large work and afterwards branched out into small work. In running a small steel-casting shop, tonnage must be forgotten; the sales price and profit are figured at so much per man, and any other method of cost-keeping is ruinous.

There are many interesting features in the moulding end of the business, but only one will be mentioned, namely, the question of green-sand *versus* dry-sand moulds. It is the writer's opinion that a larger tonnage of small castings is made in green than in dry sand. Among the advantages of the green sand system are the following :—

(1) Cost of drying is eliminated, fuel is saved and handling avoided.

(2) It is a more rapid system and turns out a greater product per unit of floor area.

(3) In snap flask work, the cores usually get only one baking.

(4) In other than snap work, the flask equipment is cheaper and may be more easily kept in good condition.

(5) Because of its yielding qualities, certain designs can be made in a green-sand mould that cannot be produced in a dry mould. This is in itself an advantage, but beyond this is the fact that castings made in green sand are not subjected to the same internal strains as those made in dry moulds. For this reason, if the writer were a purchaser of castings, he would want all intricate designs made in a yielding mould. This is a point that only few have grasped; they know that green-sand castings are satisfactory, but do not know why.

Among the disadvantages of the green sand system may be mentioned :—

(1) More skill is required on the part of the moulder, and this is a serious matter, because the moulder's wages increase in proportion to his skill.

(2) It takes more time to train a moulder for green-sand work.

(3) The number of possible operatives is less and therefore in busy times it is difficult to get a maximum production. In other words, one is not so independent in regard to labour as when dry-sand moulds were made.

(4) Under equal conditions, the number of spoiled castings is greater with green sand than with dry sand. This is due primarily to misruns, corners of snap-flask moulds dropping off, blowholes resulting from tight ramming, and over-size castings due to moulds being rammed too loosely.

The matter of properly heading and gating small steel castings is an important one. Frequently the design is such that there is no place to attach the head, yet shrinkage must be provided for. This is often overcome by chills, but in steel they are not as efficacious as in grey and malleable cast iron. The weight of the heads and gates compared with the finished product is large. If the good castings make up 45 per cent. of the total melt, the practice is about normal on small work.

The sand does not contain as much natural binder as that used for other metals, and consequently the moulds are not so fine in detail. Also, steel chills quickly, and therefore when it reaches remote parts of the mould it is not fluid and does not run well in fine, sharp corners. The high temperature of the metal has a tendency to fuse the sand. The gates are abnormally large and clean castings are therefore somewhat more difficult to get than when pouring other metals. All these influences tend to detract from the appearance of small steel castings, but recent improvements in this direction have been rapid. Much, however, remains to be done.

It is absolutely essential that the foreman in a successful small steel-casting shop have ability to rig cheaply. This is a rare talent, and few men have the initiative, experience and ability to meet this phase of the problem successfully. One may go through numerous foundries and see idle machines everywhere, simply from inability to rig cheaply.

The core department is probably the most neglected end of the business, and, except in certain malleable and grey-iron foundries, core rooms are rarely run with any degree of efficiency. The reason given by most managers for this state of affairs is that they have no repetition work. Core boxes may be divided naturally into two classes, those in which the ramming requires skill and others in which the lifting of the box requires skill. Machines are made for performing both operations. There is no reason, therefore, why the losses due to this particular cause should be very high.

To one not closely connected with the proposition, the melting problem usually appears to be the one thing of most importance. This is not true, however, for with ordinary steel conditions more money can be lost or saved in the moulding and finishing rooms. It is probable that the moulding department is the most important, but the finishing room runs a close second. In many shops, the cost per ton in the finishing department is greater than in the moulding department.

The making of small steel castings has not, as a business, been conspicuous for its great success. The reasons may be summarised as follows :—

(1) In most attempts to make small castings, the side-blow converter has been placed in unskilled hands and attempts have been made to operate the melting department on too economical a basis.

(2) The moulding has been handled as if small and large castings could be made by the same methods.

(3) Very often too little money has been considered necessary, and in many cases the available capital was not properly distributed between plant, equipment and working funds. Usually too much is put into the plant account.

(4) Cost systems have been conspicuous by their absence.

(5) The organisations have been run on too economical a scale and therefore few, if any, have realised the high cost of manufacture and the high overhead costs.

(6) Castings have been sold at too low a price.

VISIT OF BIRMINGHAM FOUNDRYMEN TO STEEL WORKS.— On Monday, June 8, the Birmingham Branch of the British Foundrymen's Association paid a visit to the Mill Street Works of Messrs. James Fairley & Sons, steel manufacturers, Birmingham. The visitors were received by Mr. A. Fairley, and Mr. James Fairley, and conducted round the works. This was the second visit, an earlier inspection having taken place about five years ago. The Mill Street Works produce open-hearth acid steel, and the visit was timed so that the foundrymen were able to watch the pouring of a 12-ton cast into 8-in. ingots. The plant includes five mills, one of which, a 10-in. mill, operated by electricity, has been installed since the last visit. It is driven by a 300 h.p. motor, having a 12-rope drive. A second 10-in. mill, also devoted to bar production, is steam driven. There is a 21-in. steam cogging mill, for the production of billets of various sizes. A special mechanical feature of this plant is a rising foot plate operated by a lever which raises not only the steel ingot in the course of treatment, but also the workmen. In addition there are two 14-in. mills devoted to the production of bars, and which are steam driven. The necessary power is derived from four Lancashire boilers. The reeling machine, which is used for straightening and brightening the bars, is operated by electricity. This machine deals with bars of various sizes from ½-in. upwards. The forging plant comprises eight steam hammers, varying in weight from 3 cwt. to 1 ton. They are mainly employed in tool forging, and are equipped with the necessary shears and saws. An overhead electric crane which serves the casting pits, has a lifting capacity of 20 tons. The firm make a very important feature of their laboratory, which is well equipped and up-to-date. Every cast produced is analysed before the metal is taken into stock, so that an exact record is always available of the whole of the production. At the close of the visit a vote of thanks to the firm was heartily carried on the proposition of Mr. Heggie seconded by Mr. Howell.

"F.T.J." Bookshelf.

The Schools and the Nation.

By Dr. Georg Kerschensteiner. (London: Macmillan & Company, Limited, St. Martin's Street.)

While an introduction by Count Haldane to a work on education may be a means of directing attention to it, this book, admirably translated by Mr. C. K. Ogden, stands well on its own merits. It is strictly a collection of addresses by Dr. Kerschensteiner, who has become well-known in educational circles as the Director of Education in Munich, the city to which all nations are turning for an example of what may be done in radical educational reform. When it is stated that Dr. Kerschensteiner bases his whole scheme of instruction on the conception of schooling as a means of training or developing the useful and desirable *citizen*, one may be tempted at first to class him as a somewhat extravagant idealist, advocating methods impracticable in a commercial age. The author, however, loses no time in showing that the training for citizenship in its widest sense is the only useful training and embraces in its most useful form all the valuable training that the present but antiquated systems of schooling offer. One is forced to agree with the author that the present methods of instruction are extravagant in expenditure of both money and energy, in view of the little permanent education effected, and this largely as the result of not taking into account the educative value of productive labour. If one were inclined to dispute the value of the latter, the results obtained under the system established at Munich would offer direct refutation of the objection. In the elementary schools the time allowed and the stage of the child's development only permit of a superficial preparation for acquiring skill in the use of the primitive instruments of reading, writing and arithmetic, and how far the knowledge of those instruments constitutes real education is evidenced by the development of thousands who are turned out from our own elementary schools as having received "a good elementary education." Under the Munich system that elementary training is made merely the commencement of the real education of the child by means of participation in useful constructive work intelligently directed. In Dr. Kerschensteiner's own words, the problem of popular education is the systematic training and organisation of the people to take pleasure in active constructive work for the common good; but it is the very nature of the problem which has hitherto been ignored, while attention has been directed instead to the instilling of a definite amount of more or less useful (or useless) abstract information into minds not sufficiently developed to assimilate it. While the Munich schools are frequently referred to as "trade schools," it must not be supposed that the mere training of the pupils for specific trades is the objective; if such were the case the whole system would stand subjected to severe criticism. Instead, the trade training is made the means of a much wider general education to fit the future citizen for adequate participation in both industrial and civic life. It is impossible in the space available at the moment to enter into details of the system; for these we must refer the reader to the book, in an appendix to which the Munich school system is concisely outlined. Suffice to say that Dr. Kerschensteiner appears to have largely solved the problem of getting an adequate return for the time and money expended on elementary schooling, by rendering that schooling really educative and linking it up to industrial and civic life without the disastrous disconnection which characterises our own system and nullifies most of the efforts of teachers and pupils alike. The book should be carefully perused by all who are interested in or concerned with the education of children; for while the conditions obtaining at Munich probably assist to a readier application of the principles upon which its system is based, these principles are none the less applicable to all conditions. Moreover, as the question is vital to national industrial progress, it calls for the closest attention of our own education authorities, who have under consideration some revision of our schooling system. Is it too much to hope that British education reformers will review the possibilities revealed in Munich, and accept without undue bias the lesson to be learned?

Practical Iron Founding.

By J. G. Horner, A.M.I.Mech.E. (London: Whittaker & Company, 2, White Hart Street, Paternoster Row, E.C.).

In the fourth edition of this book, published at the reasonable sum of 5s., the author endeavours to give a condensed account of the principles and practice of iron founding. Each branch of the work is followed through in a concise way, and a lot of really practical matter is presented. The book has been considerably enlarged and revised since the first edition, and its value thereby enhanced; but even as it stands it is more of an introduction to the subject than a comprehensive survey. It is apparently not the author's endeavour to include all the refinements of modern founding, a fact which probably accounts for the meagreness of certain portions. While not quarrelling with the brevity of parts of what admittedly sets out to present a condensed account of principles and practice, there are a few points which require careful reconsideration in the light of modern knowledge. For example, in the chapter on iron melting and mixing we are informed that "mottled iron, being a mixture of grey and white, partakes more or less of the characteristics of each, and is therefore better adapted for most castings than either of those alone." Also, "Iron is adapted for general engineer's work in proportion to its amount of mottle, highly-mottled iron being correspondingly prized by the foundryman." These statements to a student who is not a foundryman are likely to be most misleading, while to a foundryman they will not add to the writer's prestige as a foundry metallurgist. In fact, the metallurgical section of the book is both brief and weak. Discussing the virtues or otherwise of the constituents of pig-iron, the author states that the proportion of combined carbon is never more than a mere trace in the grey cast iron—a statement which requires for its acceptance an unusually wide interpretation of the term "mere trace." Silicon is portrayed as the benevolent party of the group; phosphorus and sulphur are rather doubtful characters; and manganese is dismissed with the brief statement that it "is undesirable, producing a weak and brittle iron." The chapter dealing with cupolas and blast gives the general outline of cupola practice, but does not contain much definite information for the actual foundryman. The other sections of the book show an intimate acquaintance with the foundry's various departments, and though the scope is somewhat limited, the author gives a very good idea of the requirements and principles in each direction. Despite its shortcomings, the book is a useful one and would well repay careful revision to bring it close into touch with modern foundry knowledge and practice.

D

Inventions.

Applications for Patents.

An Asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicator are in brackets.

12,425. Formation of metal ingots. J. H. Darby.
12,544. Ingot moulds. T. K. Irwin.
12,545. Gas-fired smelting-furnaces. E. Lewis.
12,546. Ingot moulds. E. Lewis.
12,598. Manufacture of chilled-iron wheels and other castings. Miller & Company, Limited, and J. White.
12,753. Stirring or agitating devices for use in connection with metallurgical furnaces, crucibles, etc. C. H. Ivinson and E. Le Bas.
12,762 *Method of making steel. W. G. Nichols.
12,800. Moulds for casting brass. J. H. Bromilow.
12,824.*Moulding-machines. J. Habscheidt.

Abstracts of British Patent Specifications recently Accepted.

14,541 (1913). *Reversible Regenerative Gas Furnaces of the Siemens' Type.* A. Reynolds, 117/119, Bank Chambers, 29, Southampton Buildings, Holborn, London, W.C.—The claims are for (1) a reversible regenerative gas-fired furnace in which separate flues and draught-inducing devices are provided for conducting the waste gases from each reversing valve system to the atmosphere; (2) a reversible regenerative gas-fired furnace, in which separate flues and draught-inducing devices are provided for conducting the waste gases from a group of gas reversing valve systems and a group of air-reversing valve systems.

5,570, (1913). *Core-making Machines.* J. J. Chipchase, 65, Brownlow Road, Horwich.—The claims of the patentee are for a core-making machine provided with a core box formed in halves having jacketted walls for heating purposes, hollow trunnions communicating with the jacketted spaces provided with slides or arms for engaging with and supporting the halves of the box and for keeping them in alignment, catch devices for securing the halves of the box together and preventing their movement on the slides, means for supporting the trunnions to enable the box to be rotated and a vertically-moving table adapted to be operated by hand so as to be engaged with the core box or with the core made by it. The core box trunnions are mounted on vertical slides adapted to be given a rapid rising and falling movement to effect a shaking or jarring motion on the core, by means of cams arranged on a suitably-rotated shaft engaging with the slides. A pivoted plate or table is also used, normally held in position by a tumbler catch for supporting one half of the core box when drawn away from the core, and for allowing of such half being turned away to one side of the machine out of the way.

28,526 (1913). *Sand Moulding Machines.* Dr. Carl Oetling, 37—38, Wilhelmstrasse, Berlin, S.W., 48, Germany.—Fig. 1 shows diagrammatically the arrangement of a machine driven by a downward pull and having swinging weights. The table *a* is supported by the extensions *b* of levers *d* loaded with swinging weights *c*, so that when at rest, as shown, it is raised. The drive is effected by gaseous or liquid fluid pressure exerted in a cylinder *e*, which forces downwards a piston *f* and thereby draws down the table of the machine by a connecting rod *g*, the weights *c* simultaneously being swung upwards. The table of the machine then strikes against an anvil *h*, which is spring mounted to avoid shaking the foundations, preferably the impact surfaces being subdivided into a number of separate abutments. The weights *c* continue to swing further after the impact and press the table further downwards on the anvil. The admission of driving fluid to the cylinder, if gaseous, can be cut off before the end of the stroke, the remainder of the stroke being effected by expansion. Fig. 2 shows a machine with swinging weights, which has both a drawn down jigging action and a pressing action. In this arrangement the swinging weights act not only on the table *a*, but also on a pressing board *i*. The swinging weights *c* are in this case provided on discs, secured on shafts *k* (see side views Figs. 3 and 4). The piston rod *g* of the piston *f* working in the cylinder *e*, is connected to a crank pin *l* of an inner pair of discs *m*, whilst the pressing board *i* is connected by rods *n* to the crank pins *o* of a pair of outer discs *p*. The swinging masses *c* are arranged at suitable positions on these discs *m* and *p*. The radius of the cranks *o* is greater than the radius of the crank *l*. The anvil here consists of separate spring mounted abutments *h*. On the piston *f* descending in the cylinder *e*, the crank *l* describes a given arc, as shown in Fig. 3, whereby the swinging masses *c* and likewise

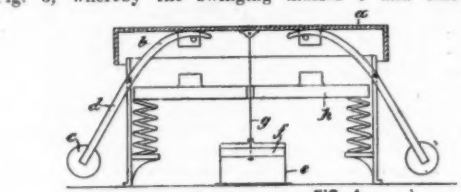


FIG. 1.

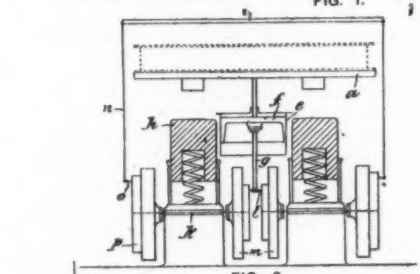


FIG. 2.

FIG. 3.

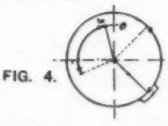


FIG. 4.

Improved Sand-Moulding Machine.

the cranks *o* are rotated through a like angle. As the result of the greater radius of the crank *o*, the linear descent of the pressing board *i*, on the table *a* of the machine being drawn down, is greater than the linear descent of the table *a*, so that the table and pressing board approach each other and a pressing action occurs. On impact of the table *a* against the anvil *h*, the upwardly swinging weights *c* exert their influence; these weights also exert a continuance of the pressing action by the pressing board *i*.

1,416 (1914). *Core-drawing Mechanism for use in the Casting of Metals.* L. Ferman, 56, Bracewell Road, Kensington, London, W., and the Mitre Works, Scrubbs Lane, Willesden, London, N.W.; and Ferman & Company, Limited, Engineers, 3, London Wall Buildings, London, E.C.—Fig. 1 is a cross sectional elevation of the mould-manipulating machine; Fig. 2 is a plan view of the mould-manipulating table itself, showing the guides or rails upon which the mould is supported when it is brought from the furnace, the adjustable dogs upon the movable inner portion of the table for gripping the core, and the toggle and bell-crank levers employed to engage with the mould and prevent it from sliding off the mould-manipulating table when the latter is tilted. The manipulating table of the mould-manipulating machine is divided into two portions, an outer portion A and an inner movable portion B. The inner movable portion B which carries the core is provided to slide vertically in recesses or guides C formed in a conveniently U-shaped framework D rigidly connected to

the lower side of the outer portion A of the manipulating table, which outer portion carries the mould. The lower or cross member of the U-shaped framework D is provided with a bearing E in which a nut F having a bevel wheel G formed integrally therewith is allowed to rotate freely although constrained as regards vertical movement. Through the nut F passes a screw-threaded rod H which is rigidly connected to the inner movable portion B of the mould-manipulating table, and with the bevel wheel G engages a second bevel wheel J keyed upon a shaft K supported in a bearing in the U-shaped framework D and operated by a hand-wheel L as shown. Thus on rotating the hand-wheel L in one direction or the other, the nut F will also be rotated and since the nut itself cannot rise or fall the screwed rod H is caused to ascend or descend carrying with it the movable inner portion B of the manipulating table. On the movable portion B are provided dogs M, the holding-down bolts N of which are adjustable in transverse inverted T-shaped slots O formed in the portion B (Fig. 2) so that the distance between the dogs can be varied to suit different cores. These dogs M are provided with grooves on their inner sides in which engage flanges on the lower portion of the mould or die when it is drawn on the manipulating table. Thus on rotation of the hand wheel L as described, the movable portion B of the manipulating table is drawn downwards together with the core and thus the latter is freed from the mould or die or the like. The U-shaped framework D is provided with oppositely-disposed trunnions P upon which it can pivot and which transmit the weight of the manipulating table to a frame Q. This frame Q is itself pivoted on oppositely-disposed trunnions R pivoted at right angles to the trunnions P in an outer framework S through which the weight is transmitted to the ground.

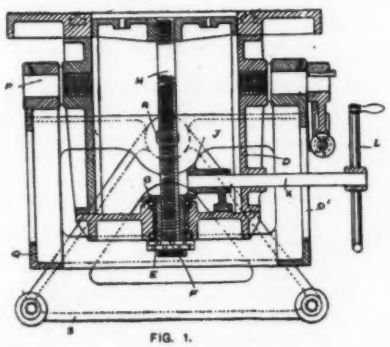


FIG. 1.

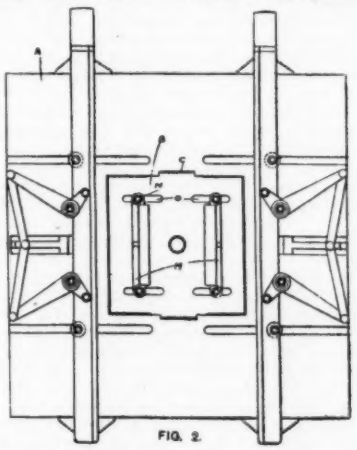


FIG. 2.

Core-drawing mechanism for use in moulding operations.

THE INSTITUTE OF METALS.—Portsmouth has been selected as the place of meeting for the autumn conference of the Institute of Metals. The conference, which will be presided over by Engineer Vice-Admiral Sir Henry J. Oram, K.C.B., F.R.S., the President of the Institute of Metals, will be held on Thursday, September 10, and Friday, September 11, in the Municipal College, a number of important Papers being read each morning. In the afternoon of September 10 a visit will be paid to Portsmouth Dockyard, and there will be a dinner in the evening. On September 11 the afternoon function will consist of a luncheon at the Cowes works of Messrs. J. Samuel White & Company, the works afterwards being inspected.

Corrosion of Iron by Caustic Soda.

In the course of a Paper, entitled "The Embrittling of Iron by Caustic Soda," communicated by Mr. J. H. Andrew to the members of the Faraday Society recently, he stated that small flat specimens of wrought iron, rough-filed and highly polished, were immersed in a concentrated aqueous solution of caustic soda at 100 deg. C. for periods lasting over several months. The specimens were examined from time to time, and it was found that the initial corrosion of the polished metal was less than that of the unpolished, but eventually both became highly crystalline, the surface of the two being similar, and their corrosion rate approximately the same. The re-crystallisation of the specimens, said the author, caused them to become extremely brittle; the brittleness eventually disappeared, however, with prolonged immersion, and during the treatment with soda hydrogen gas was evolved. Experiments were carried out with the idea of showing that hydrogen diminished the rate of corrosion. An electrolytic iron was heated to 1,000 deg. C. in hydrogen, and allowed to cool in the gas. The specimen, after this treatment corroded extremely slowly, whereas another sample of the same material untreated corroded at the normal rate. It might be concluded from these experiments that the passivity of iron produced by immersion in caustic soda was due to the decrease in potential difference between the crystalline and amorphous phases, produced by occlusion of hydrogen. A 0.5 per cent. carbon steel was affected to a much less degree by caustic soda solution. The re-crystallisation of electro-deposited iron found by Stead and Carpenter to occur when the metal was allowed to slowly cool through the Ar3 critical point, was explained upon the basis of hydrogen evolution; as the iron cooled through the critical point the evolution of hydrogen effected a re-crystallisation of the metal.

FURNACES AT THE MIDLAND RAILWAY WORKS, DERBY.—With reference to the description of the above works published in our last issue, we understand that this Company installed in October, 1912, a Morgan's tilting furnace for oil fuel, taking a crucible for 600/650 lbs. of brass, and that this was followed by a further installation of two of the same capacity at the beginning of 1913.

The Rating of Machinery.

A meeting of business men has been held at Birmingham, under the auspices of the United Manufacturers' and Merchants' Association, for the purpose of hearing an address by Mr. G. Humphrey-Davies, on "The Rating of Machinery." Mr. David Shanks presided.

In the course of his address, Mr. Humphrey-Davies said the manufacturer was now face to face with proposals which aimed at an entire alteration of our fiscal system, so far as it affected the local government of the country. Since he took up the question it had changed both in its aspect and in its surroundings. The bill of 1887, which was the first to deal with the subject, would not have altered the incidence of the rates, or the standard by which the ability of the ratepayer to contribute them was to be measured; nor did it pretend to interfere with the executive duties of the local authorities. But, under the proposals that were to be brought forward by the Government, the standard, the machinery by which effect was to be given to the levying and collection of the rate, and the persons by whom the work was to be done—all would be altered. The taxation of the machine tools and other plant and machinery in factories in accordance with the proposals and wishes of those who desired to recast the existing system would cause, whatever its advantages might be, a further serious increase in the outgoings for local rates, and, therefore, add to the burden of the English manufacturer in his competition with the foreigner. The manufacturer in Scotland at present held a great advantage over the Englishmen owing to the exemption of his machinery from rating under the Act of 1902, but under the proposals of the Departmental Committee this advantage would disappear, and the increased annual payments due to the reimposed taxation of machinery on the new system of valuation would be a further addition to the manufacturing costs in that kingdom. The policy of granting subventions from the Imperial revenue in aid of local rates had been in operation upwards of half a century, but that it had not been productive of economy in the local expenditure had been shown by the concurrent increase in the poundage of the local rates. It would be imprudent to assume that the additional subventions granted under the last Budget would have a different result. It was, therefore, apparent that, in considering all the proposals for altering the basis of local rating, those who controlled the industrial undertakings of the kingdom should direct their criticism to the effect they would have upon their competition for the home and foreign markets for their products. Mr. Humphrey-Davies pointed out, by a comparison of a result of assessing a factory in Birmingham upon the basis hitherto adopted with the result of a valuation of the same factory based upon the "total value" under the Finance Act, 1910, that the increased payment for rates due to the taxation of machinery would be £1,690. He urged the necessity of formulating some scheme for criticising and reporting upon all proposals for fiscal legislation which were likely to affect the interests of those they represented.

A discussion and questions followed, and the following resolution was proposed by the Chairman;—"In view of the statements of the Chancellor of the Exchequer in his Budget speech as to the nature of the Government bill for revising the basis of local taxation, and of the recent report of the Departmental Committee on the subject, this meeting is of opinion that a committee of leading representatives of the industries of the three kingdoms should be at once formed to consider the bill about to be introduced by the Government and its probable effect upon the interests of manufacturers. That, with this object, a copy of this resolution be immediately sent to all chambers of commerce and trade associations in the country, with a request that a representative from each should be deputed to attend a conference, to be held at an early date for the purpose of appointing members of the above committee and taking such further steps as the conference shall deem necessary."

The motion was carried, and the following gentlemen were appointed as a committee to carry out the terms of the resolution, with power to add to their number:—Messrs. E. F. Cook (Harrison and Cook), Arthur L. F. Carr (Carrs, Saltley), George H. Dugard (Dugard, Bros.), H. T. H. Cooke (J. Cooke and Sons), Wilfrid Hill (County Chemical Company), and W. Wilkinson (J. Wilkinson and Sons).

On the motion of Mr. Crowder (Dobson and Crowder), seconded by Mr. E. Wilson (General Electric Company) it was agreed:—"That this meeting of Birmingham manufacturers condemns the present alteration in the policy of the Birmingham overseers in the rating of machinery, and is of opinion that steps should be taken to formulate a strong protest through the medium of the various manufacturers' associations."

Railway Specifications for Axle-Box Metals.

The Railway Clearing House authorities have recently issued standard specifications for materials for use in the construction of private owners' wagons. The following are the specifications for brasses and white metal for use in axle-boxes to which private owners will be required to work:—

Brasses.—Brass bearings to be an alloy of copper, tin and zinc, in the following proportions:—

	Per cent.
Copper	84 to 88
Tin	10 to 12
Zinc...	2 to 4

White Metal.—White metal to be an alloy of copper, tin, antimony and lead in the following proportions:—

	Per cent.
Copper	6
Tin	60
Antimony	12
Lead	22
	100

The companies reserve to themselves the right to call for samples of brasses and white metal to enable them to ascertain the quality of the material used.

The code of instructions in respect of the application of white metal to wagon bearings is as follows:—

(1) The brass should be thoroughly cleaned, and after being heated, should be tinned on face with soft solder (one part tin and two parts lead) or in a bath of tin at a temperature of about 635 deg. Fah., the parts of the brass not to be tinned to be coated with lime-wash; the tin in either case to be applied with a flux of chloride (spirits of salts reduced by zinc).

(2) The white metal at a temperature of about 680 to 700 deg. Fah. should be applied to the brass in a suitable cast-iron mould, the mould being hand-hot, about 120 deg. Fah., and the temperature of the brass about 445 deg. Fah. The molten metal to be filled in to top of mould to prevent hollow bearing.

(3) The temperature is best ascertained by means of a pyrometer, but a workman can tell when the white metal is the right temperature by one of the following methods:—(*a*) By the rate at which the metal oxidises; when too hot it oxidises quickly and a quantity of dross is formed. (*b*) By dipping a piece of dry yellow pine for 10 seconds into the metal; the wood will slightly scorch or discolour if the metal is of the right temperature, but if too hot the wood will flame. (*c*) By placing a piece of tissue paper on the surface of the metal; the paper will blacken if the temperature is about right, but if too hot the paper will flame.

Trade Talk.

THE HERBERT ENGINEERING COMPANY, LIMITED, propose establishing works at Caversham, near Reading.

THE FRONTERO MANGANESE COMPANY LIMITED, is being wound up voluntarily, with Mr. P. Boyle Gilroy, 8, Arthur Street, London, E.C., as liquidator.

THE CARRON COMPANY have removed their West End premises to 50, Berners Street, Oxford Street, London, W.

A FIRE has occurred at the Vulcan Road Works, Sheffield, of Edgar Allen & Company, Limited, but the damage was only slight.

STEWARTS & LLOYDS, LIMITED of Glasgow have removed their Birmingham offices from Nile Street to Broad Street Chambers, Birmingham.

MR. J. GILL, ironfounder, Queen's Foundry, Saw Yard, Wakefield, has paid a first and final dividend of 4s. 10d. in the £.

ON Saturday, June 6, a very interesting visit was paid by members of the Institute of Marine Engineers to the works of J. & E. Hall, Limited, Dartford.

PEASE & PARTNERS, LIMITED, of Darlington, have now become the absolute owners of the Tees Ironworks, Middlesbrough, of Wilson's, Pease & Company, Limited.

E. BENNETT & SON, LIMITED, 7, Aldersgate East Chambers, London, E., have appointed Mr. H. Grimmer, 53, Wokingham Road, Reading, as their agent in the West of England.

JOHN & JOSEPH TAUNTON, LIMITED, Belgrave Works, Sherbourne Road, Balsall Heath, Birmingham, have removed their London premises to Perry's Place, 70a, Oxford Street, W.

EDGAR A. J. HOOPER, LIMITED brassfounders, of the Eagle Works, 107, Hospital Street, Birmingham, have appointed Mr. E. Kidson as their representative for the Midlands and the South Coast.

PLANS for the offices of the British Mannesmann Tube Company's new works at Newport have been submitted to the works committee of the Newport Corporation and approved.

THE engineering business carried on by Mr. Malcolm M'Lean, under the style of M. M'Lean and Company, at 82, Howard Street, Glasgow, has been sold to Mr. Edwin Cameron Henderson, who will continue it under the same name.

MR. W. L. HICHENS, chairman of Cammell, Laird & Company, Limited, has entertained at Sheffield the whole of the company's staff in celebration of the 50th anniversary of the company as a limited liability concern. All the directors and officials were present.

THE Cairnhill Works of the Scottish Iron and Steel Company, Limited, were closed on June 13 for an indefinite period. Four of the other works have been closed for some time, and there are now in operation nine out of the works controlled by the company.

THE partnership heretofore subsisting between Messrs. W. J. Douglas and W. R. Whitson, carrying on business as consulting engineers at 1, Fenchurch Avenue, London, E.C., under the style of Douglas & Adair, has been dissolved. The business will be carried on in the future by Mr. Douglas.

MESSRS. KEY & MURRAY, engineers, 42 to 44, Carrick Street, Glasgow, and W. Key and S. D. Murray, the sole partners of the firm, have suspended payment and granted a trust deed on behalf of their creditors in favour of Mr. L. C. Gray, 104, West George Street, Glasgow.

THE BRITISH ENGINEERING COMPANY OF SIBERIA, LIMITED, of Central House, Kingsway, London, W.C., has been formed with the object of assisting in the commercial development of Siberia. The principal business of the concern is the representation of British engineering and other manufacturing firms.

IN the Court of Session at Edinburgh, a petition has been presented by Pickford, Holland and Company, Limited, Eclipse Ganister Works, Attercliffe Road, Sheffield, for the compulsory winding-up of C. W. Robinson & Company, Limited, Forth Bridge Steel Works, Polmont Station, Linlithgowshire.

THE co-partnership of A. and P. Steven, engineers, 181, St. James Road, Glasgow, of which Messrs. J. Alex. Steven and J. Klinkenberg, were the sole partners, was dissolved on June 3, 1914, by the retirement of Mr. John Klinkenberg. The business will be carried on by Messrs. John Alex. Steven and John Monteith Steven.

THE SULLIVAN MACHINERY COMPANY, whose London offices are at Salisbury House, E.C., announces that Mr. J. C. West, hitherto their manager at San Francisco, has been transferred to the general offices at Chicago, in the capacity of general sales engineer. Mr. R. P. McGrath has been appointed district manager at San Francisco.

AT a meeting of the shareholders of the Carlton Iron Company, Limited, held at the Carlton Iron Works, Stillington, via Ferryhill, the following resolution was duly passed :—"That it is desirable to reconstruct the Company, and accordingly that the Company be wound up voluntarily, and that William Thomlinson, of Seaton Carew, in the county of Durham, ironmaster, be and he is hereby appointed liquidator for the purposes of such winding-up."

MORRIS & LISTER, LIMITED, of 3 and 4, Palace Chambers, Bridge Street, Westminster, S.W., and Carlton Works, Lockhurst Lane, Coventry, who have hitherto represented Nalder Brothers, & Thompson, Limited, electrical and mechanical engineers, to a limited extent, have now been appointed the company's representatives in the London and country districts heretofore worked by Messrs. Frampton & Paine, whose agreement for the agency has now expired.

A MEETING of the shareholders of Wheatman & Smith, Limited, steel makers, of Kelham Island, Sheffield, has been held at the Cutlers' Hall, for the purpose of confirming resolutions passed at a meeting on May 27. The resolutions, which were duly confirmed, provide for the sale of the goodwill, stock-in-trade, plant, machinery and trade marks of the company. The purchasers are Alfred Beckett & Sons, Limited, steel and file manufacturers, Brooklyn Works, Green Lane, Sheffield. For the purpose of carrying into effect the agreement entered into with Messrs. Beckett, the business of Wheatman & Smith will be voluntarily wound up. The freehold land, buildings and other assets of the company are not included in the agreement, and will be disposed of by Mr. Charles R. Hides, the secretary of the company, who has been appointed liquidator.

WE have received from Mr. H. G. Williams, the secretary and general manager of the Second International Engineering and Machinery Exhibition, organised by the Machine Tool and Engineering Association, Limited, a copy of the exhibitor's guide and a plan of the exhibition, which will be held at Olympia from September 28 to October 18, 1916. Application for space prior to June 1, 1915, will be received from members of the association only. Exhibits on stands adjoining the central gangways must consist of heavy machinery or plant, to be shown in operation where possible. The charges for space will be from 2s. 6d. to 4s. per square foot, according to position, and must be paid as follows :—10 per cent. on allotment, 40 per cent. on March 31, 1916, and the balance on September 28, 1916. In the case of allotments subsequent to March 31, 1916, the payment on allotment shall be 50 per cent. The association will supply platforms, if required, to its members only free of charge. Members not availing themselves of this offer will be allowed a rebate of 2d. per square foot. Exhibitors must provide all necessary stand fittings, decorations, wiring and fittings for the electric power and lighting they require. The current will be supplied by the association. The following firms have been appointed official contractors to the exhibition :—Electricians : Brooks & White, 10, Maclise Road, Kensington, W., London ; Jacob White & Company, Limited, 324, Upper Street, Islington, N. ; W. C. Tacklev & Company, Limited, 30, Blythe Road, Kensington, W. ; Universal Electric Contracts, Limited, 7, Maclise Road, Kensington, W. In accordance with the Patent and Designs Act, 1907, protection will be applied for from the Board of Trade for persons desirous of exhibiting new inventions.

Visit of Herr Krupp to Great Britain.

Herr Krupp von Bohlen und Halbach, the head of the Krupp works at Essen, with other officials, have lately made a tour of inspection of the manufacturing centres of this country. On June 15 Herr Krupp, together with Herr von Bulow, paid a visit to Messrs. Cammell, Laird's works at Birkenhead. Among the guests invited to meet the visitors were Lord Derby, Sir H. Robertson (chairman of the Dock Board), and Sir William Lever. The visitors were taken over the yard, and shown all the vessels under construction, concerning which they expressed themselves deeply interested. On June 16 the party visited Messrs. Vickers' naval construction works at Barrow. They were met by Mr. Albert Vickers (chairman of the company) and other directors, and were escorted through the extensive shops. Two of the latest super-Dreadnoughts, in addition to several other warships, were subsequently inspected. After lunch the visitors motored to the new naval airship depôt at Walney, where Messrs. Vickers are building five airships.

After visiting Barrow the party went to the Elswick Works, on the Tyne, and also inspected the new Armstrong shipyard at Walker. Later the visitors journeyed to Sheffield, and inspected the East Hecla Works of Hadfields, Limited, the River Don Works of Vickers, Limited, the Cyclops Works of Cammell Laird & Company, Limited, the works of Thos. Firth & Sons, Limited, and the Atlas Works of John Brown & Company, Limited.

During their stay in Sheffield the visitors were the guests of Sir Robert and Lady Hadfield at Parkhead. At the East Hecla Works the party were received by Sir Robert Hadfield, Mr. A. M. Jack, Mr. W. H. Dixon, Major Clark, Mr. H. Cooper and Mr. J. B. Milne. Sir Robert Hadfield, in expressing his pleasure at the visit of Herr Krupp von Bohlen and his friends, said that Germany was one of our biggest and best customers, and commercial rivalry was good for us all. "You come to the city of Sheffield," continued Sir Robert, "where Huntsman first produced cast steel in the middle of the eighteenth century, and where the highest quality has been produced ever since. We had present last evening the Vice-Chancellor of our University, Mr. Fisher. In an address not long ago he wisely told us that our University was not for Sheffield only; that is to say, we were not to keep selfishly for our own exclusive possession the knowledge we gained. I think in the past we have set this example, for Sheffield has in many ways by the researches of its men of science placed freely at the disposal of the world much which helped to bring about metallurgical progress. We have had Huntsman; Sorby, who inaugurated microscopical study of iron and steel; Brown, who did so much to bring Sheffield to the fore; Earnshaw, Senior Wrangler, who did so much to advance the cause of education in our city; Bessemer, whose process was first made a real practical success here; Arnold, too, who has done so much for metallurgical research. The study of alloy steels has also largely originated in this city and spread throughout the whole world. Therefore, as brother metallurgists, we trust of no mean repute, we welcome you, Herr Krupp von Bohlen, as representative of all that is good and making for progress in German metallurgy, you who are at the head of this mighty organisation which gives its studies and its energies to the production of the metal to which we in Sheffield are also so devoted."

Herr Krupp von Bohlen expressed warm thanks for the reception he had been accorded. "Sheffield being the home of cast steel," he said, "it is with double interest that we have come here. We never forget that, and we always consider ourselves pupils of England in that respect." They were very glad that for such a number of years the firms of both countries had been enjoying friendly relations, and he expressed the hope that those relations would continue. As Sir Robert Hadfield had mentioned the political side, he should like to say that he thought that if it were possible for them to have good relations between the German and British firms he did not see why the political relations, which were founded so largely on commercial interests, should not also be friendly.

Deaths.

Mr. John Brand, ironfounder, of Dennistoun, Glasgow, died recently at the age of 73 years.

Mr. H. Bull, who was for a long period secretary of John Henry Andrew & Company, Limited, Toledo Steel Works, Sheffield, died recently.

The death is announced at Newcastle-under-Lyme of Mr. George James Crosbie Dawson, engineer to the North Staffordshire Railway Company.

Mr. John Russell, of Derby, died on June 23 after a long illness. He was head of the firm of R. Russell and Sons, Limited, Peel Foundry.

Mr. J. E. Mills, at one time a director of the Exors. of James Mills, Limited, Bredbury Steel Works and Rolling Mills, near Stockport, died recently at the age of 60 years.

Mr. G. H. Harrison, of Geo. Harrison & Company, Limited, Ure Bank Engine Works, Ripon, died recently. After carrying out engineering projects abroad, the deceased returned to this country in 1893, and commenced the business of Geo. Harrison and Company, Limited, at Ripon.

The death took place on June 21, at his residence, Killay House, near Swansea, of Mr. Morgan Bransby Williams, an eminent engineer and railway director, at the advanced age of 90. Mr. Williams belonged to a well-known Welsh family, and was an eminent railway engineer, being one of the original promoters of the Rhondda and Swansea Bay Railway. He had also carried out in his younger days important engineering undertakings on the Continent, especially in Russia.

The death has occurred at his residence, 12, Claremont Crescent, Sheffield, of Mr. Edwin Leadbeater, founder and senior partner in the firm of Leadbeater & Scott, steel manufacturers, Penistone Road, Sheffield. Mr. Leadbeater, who was 74 years of age, was born at Wadsley. At a comparatively early age he went to America, where he gained a valuable business training, and on returning to Sheffield in 1869 he was appointed to a responsible position by a steel firm in Millsands. Subsequently he started a small business in Penistone Road, and later took Mr. F. L. Scott into partnership.

Mr. Joseph Cliff, J.P., D.L., a director of the Frodingham Iron and Steel Company, Limited, has died at Scawby Grove, near Brigg. Mr. Cliff had for several years been in a feeble state of health. He was 73 years of age, and went to live in North Lincolnshire over 30 years ago. At that time it was ascertained that the Frodingham district was rich in jronstone, and Mr. Cliff, with others, started the steel works at Frodingham, which now employ over 1,500 hands. He did not identify himself prominently with public affairs, but for many years he sat on the Scunthorpe Bench, and for a long period was chairman at the Brigg Court.

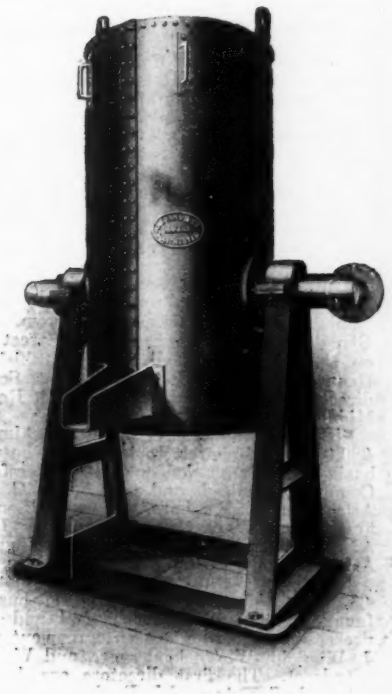
Mr. Henry J. Wilson, a director of the Sheffield Smelting Company, Limited, and a former member of Parliament for the Holmfirth Division of Yorkshire, died on June 29, aged 82. The deceased was the son of Mr. William Wilson, of Sherwood Hall, Mansfield, and afterwards of Torquay. His mother was the daughter of Mr. Joseph Read, of Wincobank Hall. The family of Read had for several generations been engaged in the refining of precious metals, a business which was first introduced and carried on to a great extent by Mr. John Read, who settled in Sheffield about the year 1765, and who was Mr. H. J. Wilson's great-grandfather. In 1869 Mr. Wilson went to Sheffield to engage in this business. His brother, Mr. Wycliffe Wilson, was associated with him, and at present the business, which has been turned into a limited company under the title of the Sheffield Smelting Company, Limited, is managed by a younger generation, sons of the two brothers.

AS SUPPLIED TO THE ADMIRALTY, WAR OFFICE, COLONIES, AND FOREIGN GOVERNMENTS.

THE Cupola. Evans's Rapid.

Foundries Completely Furnished.

EVANS'S NEW CUPOLETTE
For Emergency Work.



James Evans & Co.,
Britannia Works,
Blackfriars,
MANCHESTER.

Telegrams: "LADLES, MANCHESTER."
Telephone: 2297 CENTRAL, MANCHESTER.

New Companies

Electro Steel Foundries, Limited.—Capital £45,000 in £1 shares.

Die Castings, Limited.—Capital £2,250 in 3s. shares. Registered office : 195, Strand, London, W.C.

Geo. W. Green & Company (Feltham), Limited.—Capital £5,000 in £1 shares, to carry on the business of engineers. Registered office ; Q-Fel Works, Feltham, Middlesex

Ford & Russell, Limited.—Capital £5,000 in £1 shares, to take over the business of engineers. Registered office : Pamber Street, Walmer Road, Notting Hill, London, W.

Wheadon & Arbutt, Limited.—Capital £2,000 in £1 shares, to carry on the business of general engineers, etc. The first directors are T. Arnold, A. A. Butterworth and J. W. Wheadon.

James Blair, Limited.—Capital £2,000 in £1 shares, to carry on the business of ironfounders. The first directors are J. Blair and R. S. Blair. Registered office : 44a, Townsend Street, Belfast.

Simpson & Company (Leicester), Limited.—Capital £5,000 in £1 shares (4,500 preference), to carry on the business of engineers. The first directors are H. A. Thornton, S. P. Thornton, G. W. Massey, F. B. Thornton, C. J. Campion and H. L. R. Bell.

Macaulay, Hosie & Company, Limited.—Capital £5,000 in £1 shares, to take over the business of engineers carried on by C. A. Macaulay and J. Hosie at the Ely Engineering Works, Pontyclun, Glam., as Macaulay, Hosie & Company.

Enoch Haley, Limited.—Capital £1,000 in £1 shares, to take over the business carried on by Messrs. H. R. Haley and E. Haley, jun., at Thornton Road, Bradford, as Enoch Haley, and to act as brass, iron, bell, bronze and general metal founders, etc. The persons named are the first directors.

Grahams (Sheffield), Limited.—Capital £5,000 in £1 shares (2,500 6 per cent. cumulative preference), to take over (1) the business carried on by G. Graham at the Invicta Steel Works, Sheffield, as Grahams & Company, and (2) the business carried on by G. M. Graham at Sheffield as Marlow, Graham & Company, and to carry on the business of steel makers and converters, etc.

J. P. Rennoldson & Sons, Limited.—Capital £50,000 in £1 shares, to take over the business of engineers, shipbuilders, etc., carried on at premises in Wapping Street, Shadwell Street and Pilot Street, and abutting on the River Tyne, all in South Shields, by J. M. Rennoldson, as J. P. Rennoldson & Sons. The first directors are J. M. Rennoldson, C. Ross and J. M. Middleton.

Fisher, Humphries & Company, Limited.—Capital £80,000 in £1 shares, to take over the portion of the business lately carried on by the Horsfall Destructor Company, Limited, and now by A. C. Hutt, at the Atlas Works, Pershore, as general engineers. The first directors are Colonel H. E. M. Lindsay, C.B., A. P. James and A. C. Hutt. Registered office: Atlas Works, Pershore, Worcestershire.

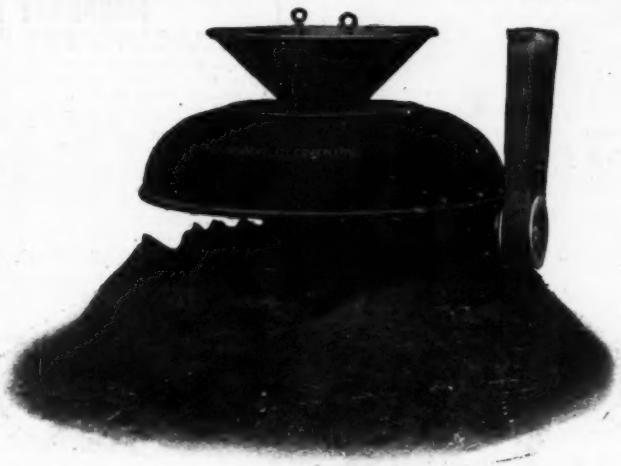
Rowditch Foundry Company, Limited.—Capital £500 in £1 shares to carry on the business of ironfounders, consulting, mechanical and general engineers, etc., and to adopt an agreement with A. Toon, J. Winfield, W. Tucker, senr., and W. Tucker, junr. (vendors). The first directors are A. Toon and J. Winfield. Secretary, W. Raybould. Registered office: Theatre Chambers, Babington Lane, Derby.

Robert Hudson, Limited.—Capital £100,000 in £1 shares, to take over the business of engineers, ironfounders, etc., carried on at Gildersome Foundry, near Leeds, and elsewhere, as Robert Hudson, and to adopt an agreement with Mrs. H. Hulson. The first directors are P. Hudson, W. S. Hudson, P. A. Hudson, and E. Hudson (all permanent). Registered office: Gildersome Foundry, Gildersome, near Leeds.

W. A. Hiscox, Limited.—Capital £5,000 in £1 shares, to take over the business of mechanical engineers, ironfounders, etc., carried on by W. A. Hiscox, E. C. Hiscox, and W. H. Wagner, as W. A. Hiscox & Company, at Stuart Works, Phœnix Street, Derby. The first directors are W. A. Hiscox, E. C. Hiscox and W. H. Wagner, each of whom may retain office while holding 200 shares. Registered office : Stuart Works, Phœnix Street, Derby.

Direct Copper Production Syndicate, Limited.—Capital £10,000 in 6,000 "A" and 4,000 "B" shares of £1 each, to take over certain inventions relating to processes and apparatus for the direct production of copper cathode plates, sheets, tubes or wire from copper ores or from crude copper, and to adopt an agreement with Sherard O. Cowper-Coles. The first directors are Sherard O. Cowper-Coles, J. J. G. Gordon, T. Bolton, E. M. Fox and the Right Hon. Sir T. Vesey Strong, P.C., K.C.B. Sherard O. Cowper-Coles may retain office for life, and may, while holding 2,000 shares, nominate one director (or, if he resigns, two directors).

THE USE OF PULVERISED COAL.—It is about ten years since the American Iron and Steel Manufacturing Company, of Lebanon, Pennsylvania, commenced the experimental use of pulverised coal in its furnaces. From the first it was apparent that the successful use of this form of fuel depended upon the absolute control of the feed to the burner. After considerable experiments, a suitable feeding device was developed, and at the present time the Company is burning pulverised coal in over 100 furnaces of various types. The fuel is pulverised so that over 80 per cent. will pass through a 200-mesh sieve. The burners feed from 40 to 900 pounds of coal per hour, depending upon the amount of heat required. Experiments made last spring indicate that from 1,169 to 1,472 lbs. of coal are required to produce one ton of puddle bar from grey forge pig-iron. The coal is conveyed automatically from the wagons to the pile, from which it is taken by screw conveyors to the dryers and pulverisers. As the coal leaves the pulveriser plant it is weighed on a large automatic scale. Screw conveyors are also used for conveying the pulverised fuel to the various points of consumption. A tank or hopper of sufficient size to carry about 15 hours' supply of pulverised coal is attached to each of the furnaces. On several occasions the fuel has ignited in these hoppers, usually on Monday morning, when it has had time to accumulate moisture. In such cases it is only necessary to stop the supply and to feed the burning coal into the furnace until the hopper is empty. There is no danger of explosion under these conditions. The fuel is delivered to the puddling and heating furnaces at a low-air pressure, from four to six ounces of blast pressure being used to deliver the coal through a small pipe to the large blast pipe, which in a heating furnace is from 10 to 14 in. in diameter. In 1907 the average quantity of unpulverised coal required to produce a ton of puddled bar was 2,052 lbs.; in 1908 it was 2,034 lbs. Tests made in 1913 indicated that from 516 to 570 lbs. of pulverised coal are required for heating one ton of iron in the piling furnaces. The records of the Company show that the cost of preparing pulverised coal in 1912 was slightly over 2s. 6d. per ton, including transmission through pipes to the furnaces. If the cost of transmission is separated from the actual preparation of the coal, the cost of the latter would be less than 1s. 8d. a ton. The experience of the American Iron and Steel Manufacturing Company has been so satisfactory that it is now largely increasing its installation for burning powdered coal and is making arrangements to apply it to open-hearth steel furnaces.



Patent Sand Mixer

Uses up more old sand than has hitherto been considered possible.

Our Patent Sand Mixer has the following desirable advantages.

The sand is thoroughly aerated, rendered light and loose in texture and of even temper.

Previous milling of the sand is unnecessary.

Seven hundredweights of sand dealt with per minute.

All bearings are ball bearings.

All gears are casehardened steel.

All gears and bearings run in an oil-bath rendering them practically everlasting.

Cages easily examined and cleaned.

Cages do not clog as there are no curved passages.

Machines can be seen in operation in our foundries, Edgwick, Coventry.

ALFRED HERBERT, Limited,

Coventry.

Personal.

Mr. Septimus Young, the London manager of Head, Wrightson & Company, Limited, has been elected a director of the company.

Mr. G. W. Crompton has been elected chairman of the Stanton Ironworks Company, Limited, in place of the late Mr. J. G. Crompton.

Mr. W. E. Jackson, a director and secretary of the Judson-Jackson Company, Limited, 50, Marsham Street, Westminster, London, S.W., has resigned.

Mr. H. M'Aughtry, who has been prominently associated with Arrol-Johnston, Limited, for the past 13 years, has been appointed manager to Belhaven, Limited.

The late Mr. R. English, a director of Fraser & Chalmers, Limited, left estate of the gross value of £345,247 16s. 3d., of which £343,520 19s. 3d. is net personalty.

Mr. E. Parkinson, of Messrs. J. Parkinson & Son, Canal Ironworks, Shipley, has been the recipient of a presentation from the employés of the firm "in recognition of the efforts he has always made for their welfare and advancement."

The late Mr. F. J. Trewent, formerly connected with Earle's Shipbuilding and Engineering Company, Limited, of Hull, and later with R. & W. Hawthorn, Leslie, & Company, Limited, at Hebburn, left estate valued at £57,190 gross.

Mr. E. W. Browne has been appointed by Bruce Peebles & Company, Limited, as their Birmingham office manager in place of Mr. Hilton, who has resigned that position to take up other work. Mr. Browne has been connected with Bruce Peebles & Company, Limited, for many years.

The degree of Doctor of Metallurgy has been conferred upon Professor A. A. Read, head of the department of metallurgy and dean of the Faculty of Science at the University College, Cardiff, at a congregation of the University of Sheffield, in recognition of his researches in metallurgy.

Sir Robert Hadfield, who, some time ago, offered three prizes of £200 each respectively to America, England and the Continent of Europe to encourage research on carbides amongst the junior members of the metallurgical profession, has also, in view of the termination of the researches on the double carbides of steel carried out by Drs. Arnold and Read, under a "grant in aid" of £300 from the Council of the Institution of Mechanical Engineers, offered these investigators a further "grant in aid" of £200 for research on the triple and quadruple carbides of high-speed steels, on condition that the results of the research are communicated to the Iron and Steel Institute. We understand that Professors Arnold and Read have accepted Sir Robert's generous offer.

FANS AND BLOWERS AND OTHER FOUNDRY MACHINERY FOR SALE.

BARGAINS FOR PROMPT CASH.

No. – Root's Blower "Acme" for 20 smiths' fires.
One ditto, with high-speed Vertical Engine combined.
Thwaites Roots Blower, 11½" discharge.
"B" Roots Blower by Alldays.
Foundry Blowing Fan, 36" impeller, 19" discharge, also 9½" round outlet to fit on same.
14" Schiele patent Blast Fan.
Lloyd's patent Blowing Fan for 50 smiths' fires.
New Roots pattern Blower, 5".
Silent Blowing Fans, 8½", 8" and 9" discharge.
Ball Mill, with drum, 2' 7" and 5' 8" outside by 1' 7" wide.
Improved Foundry Core Ovens, portable type and for fixing in wall.
4' 6" diameter UNDERGEARED LOAM MILL, with stationary pan.

CHARLES D. PHILLIPS,

EMLYN & CENTRAL ENGINEERING WORKS, NEW PORT, MON.

BLOFIL

THE

IRON CEMENT

(Quick or slow setting grades)

IS

THE CHEAPEST

AND

MOST RELIABLE

for all purposes.

Unaffected by oil, steam, or water.

Sole manufacturers—

RUDD & OWEN

(DEPT I)

Telegrams "Theripnene," Hull.

HULL

Telephone National 1223.

GANISTER, CUPOLA BLOCKS, FIRE BRICKS,

FIRE CLAY.

Silica Bricks, Tuyeres, Stoppers, Nozzles, &c.

STEEL MOULDERS' COMPOSITION, SILICA CEMENT.

J. GRAYSON LOWOOD & Co., Ltd.,

DEEPCAR, nr. SHEFFIELD.

Telegrams: "LOWOOD, DEEPCAR."

TRADE SIROCCO MARK

CUPOLA FANS.

Made in eight sizes from 10-in. to 35-in. diameter, and suitable for melting ½ to 20 tons per hour at pressures from 12—30 inches Watergauge.

Cast Iron Casings and Ball Bearings.

Double Inlet. All Types of Discharge.

Write for Bulletin No. 2028F.

DAVIDSON & CO., LIMITED,

Sirocco Engineering Works,

BELFAST.

ELDERS FOUNDRY COKE

AS SUPPLIED TO THE BRITISH ADMIRALTY DOCKYARDS.

The following, selected from numerous letters, are eminent testimony as to the quality of our celebrated "A.A.A." Coppee Foundry Coke, carefully selected, and despatched in sheeted wagons.

From PECKETT & SONS, Bristol.

Bristol, October 25th, 1904.

We have been using your Selected Foundry Coke for some considerable time. We have pleasure in stating that we are very pleased with it, as we find we get sounder and cleaner castings, more free from blowholes and other defects, than we formerly did.

From BOW, McLACHLAN & CO., LTD. (Paisley Foundry), Paisley, Glasgow.

Paisley, 12th March, 1909.

We have yours of 4th inst., and in reply have pleasure in stating that we have been using your Foundry Coke for several years for special purposes with highly satisfactory results.

Elders Collieries, Ltd., Cardiff.

Telegraph : ELDER, CARDIFF. **Telephone : 4640 and 4641.**

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining on the first day of the current month.

Pig-Iron.

	July 10. s. d.
Cleveland.	
Cleveland No. 1	54 0
,, No. 3	51 6
,, No. 4 foundry	51 3
,, No. 4 forge	50 9
,, Mottled	50 6
,, White	50 6
East Coast hematite, mixed Nos. ..	59 0
Cleveland warrants	51 5

Above prices are for early f.o.b. deliveries, and as regards Cleveland iron are for G.M.B. brands. The warrant quotations are the sellers cash prices.

Scotland.

	s. d.
Standard Foundry (Glasgow Market settlement price)	51 0
Warrants, ditto	57 4½

Makers' prices :—	s. d.		s. d.
Gartsherrie No. 1..	66 6	No. 3..	61 6
Coltness No. 1..	—	No. 3..	—
Summerlee No. 1..	66 6	No. 3..	61 6
Langloan No. 1..	66 6	No. 3..	61 6
Calder No. 1..	66 6	No. 3..	61 0
Clyde No. 1..	66 0	No. 3..	60 0
Carnbroe No. 1..	65 6	No. 3..	61 6
Monkland No. 1..	61 0	No. 3..	59 6
Shotts No. 1..	66 6	No. 3..	61 6

(All deliverable alongside Glasgow.)

Glengarnock	No. 1 .	70 0	No. 3..	65 0
Eglinton	No. 1..	60 0	No. 3..	59 0

(All deliverable alongside Ardrossan.)

Dalmellington	No. 1	61 0	No. 3..	59 0

(Deliverable alongside Ayr.)

Carron	No. 1..	67 0	No. 3..	62 0

(F.a.s. Grangemouth.)

Lancashire.

	s. d.	s. d.
Lancashire No 3 foundry f.o.t.	—	55 0
Lincolnshire No. 3 foundry ..	—	55 0
Derbyshire No. 3 foundry ..	—	56 0
Staffordshire No. 3 foundry ..	—	55 6
Cleveland No. 3 foundry ..	60 0	60 8

(All delivered equal Manchester.)

Scotch No. 3	Gartsherrie	66 6	67 0
	Glengarnock	65 0	67 6
	Eglinton	—	64 0
	Summerlee	66 0	66 6

(Delivered Manchester Docks.)

North-West of England.

	s. d.	s. d.
Bessemer mixed numbers net f.o.b.	64 0	65 0
Hematite warrant net cash ..	—	61 0
Lorn cold-blast charcoal iron ..	—	200 0

The Midlands.

		s. d.	s. d.
Staffs.	Common forge ..	49 0	50 0
	Part Mine forge ..	51 0	52 0
	Best All Mine ..	85 0	90 0
	Cold Blast	—	125 0

Strong forge, about 1s. less than grey forge; Mottled and White, about 2s. less than forge; Foundry No. 3, 3s. to 5s. above forge; No. 1 and No. 2, from 1s. 6d. to 2s. above No. 3; No. 1, about 2s. above No. 2.

Northampton foundry	51 0	51 6
North Staffs. foundry	61 0	62 0
Derby foundry	58 0	59 0
Nottinghamshire foundry ..	66 0	67 0
Leicestershire foundry	—	59 0
Shropshire Cold-Blast	—	125 0

(Delivered South Staffordshire Works, net cash monthly.)

Lincolnshire.

	s. d.	s. d.
Forge	—	49 0
Grey forge..	—	49 0
Basic	50 0	51 0
No. 3 foundry	50 0	51 0
No. 4 foundry	49 6	50 0

F.o.t. Makers' works.

South Wales.

	s. d.	s. d.
Welsh Hematite	62 6	63 0

Ferro-Alloys.

Net, Delivered Sheffield Steel works.

	£ s. d.	£ s. d.
Ferro-chrome : 4/6% carbon. Basis 60%, scale 10s. per unit. Per ton	21 0	0
Ferro-chrome : 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	19 0	0
Ferro-chrome : 8/10% carbon. Basis 60%, scale 8s. 6d. per unit. Per ton	17 15	0
Ferro-chrome : Specially refined, guaranteed maximum 2% carbon, broken to small pieces for use in best quality crucible steels. Basis 60%, scale 22s. per unit. Per ton	49 15	0
Ferro-vanadium : 33/40% Va., per lb. of Va. contained in the alloy ..	0 10	0
Ferro-silicon : 45/50%. Basis 50%, 5s. scale per unit .. Per ton	10 15	0
Ferro-titanium : 15/18%, per pound, flat	0 0	6½
Ferro-molybdenum : 70/80% Mo. per pound of Mo. contained	0 10	9
Ferro-phosphorus : 20/25%. Per ton	13 10	0
*Ferro-manganese 80%	9 0	0
,, export..	8 5 0	8 10 0

* F.o.b. Liverpool.

Iron Castings.

Cleveland.

	£ s. d.	£ s. d.
Columns (plain)	7 7 6	to 7 12 6
Pipes, 1½ to 2½ in. ..	6 2 6	6 7 6
,, 3 to 4 in. ..	5 15 0	5 17 6
,, 5 to 8 in. ..	5 10 0	5 12 6
,, 10 to 16 in. ..	5 12 6	—
,, 18 to 24 in. ..	5 12 6	—
Chairs	4 5 0	4 6 0
Floor plates (open sand)	3 10 0	3 12 6

(At works.)

Non-Ferrous Metals.

	July 13. £ s. d.
Copper.	
Standard Cash	61 10 0
Three months	62 2 0
Electrolytic	63 1 0
Tough	65 5 0
Best selected	65 15 0
Tin.	
Standard, Cash	146 15 0
,, Three months ..	148 5 0
English Ingots	148 10 0
Bars	149 10 0
Refined	151 10 0
Spelter.	
Silesian	21 12 6
Specials	22 12 6
Hard	19 0 0
British	22 7 6
Lead.	
Soft foreign	19 5 0
English	19 10 0
Antimony.	
Regulus	26 5 0 to 28 0 0
Aluminium.	
Virgin Metal, 98/99% .. per ton	85 0 0
***Chromium (Metallic).**	
98/99% purity per lb.	2s. 4½d to 0 2 6
***Nickel.**	
In cubes, 98/99% purity Per ton	162 0 0
***Tungsten Metal Powder.**	
96/93% purity .. .. per lb.	0 2 4½
***Molybdenum Metal.**	
96/98% purity.. per lb.	10s. 6d. to 0 11 0
***Cobalt Metal.**	
97% purity .. per lb.	6s. 9d. to 0 7 0
Quicksilver.	
75 lb. bottle	6 15 0

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s. d.	s. d.
Steel scrap, heavy melting ..	44 0	to 45 0
Iron scrap cast (cupola metal)	50 0	52 6

London (f.o.b.).

Heavy steel	42 0
Light ,, ...	34 0
Heavy cast ,, ...	46 0

Non-Ferrous Scrap.

London merchants quote, delivery free, and subject to market fluctuations :—

	J. B. Garnham and Sons, £ s. d.	A. Joseph. £ s. d.
Brass	40 0 0	40 0 0
Clean copper	58 0 0	57 0 0
Braziery copper ..	53 0 0	51 0 0
Old lead	17 0 0	17 15 0
Tea lead	—	16 5 0
Old zinc	16 0 0	15 15 0
Hollow pewter ..	84 0 0	90 0 0
Black pewter (shaped)	58 0 0	60 0 0
Gun metal	52 10 0	52 0 0
Aluminium (cast) ..	—	—
,, (cuttings)		62 0 0

Stocks.

Pig-Iron in Public Store.

	July 9. Tons.	Inc. + or Dec. — since July 10 1913. Tons.
Connal's at Glasgow Scotch	1,000	No change.
Ditto other makes ..	2	−68
Connal's at Middlesbrough	78,581	− 127,146
Connal's at Middlesbrough hematite ..	—	No change.
West Coast hematite..	4,984	−18,665

Metals.

Copper, Europe and afloat	33,746	−5,750
Tin, London, Holland, U.S.A. and afloat	18,574	+5,671

Coke.

Middlesbrough.

	s. d.	s. d.
Gas Coke	—	to 11 6
Foundry Coke	—	19 0
Furnace coke	—	17 6

Newcastle-on-Tyne.

	F.o.b. Dunston. s. d.
FOUNDRY COKE—	
Original Garesfield	20 6
Mickley	20 0
Stella Garesfield	20 0
Priestman's Garesfield	20 6
Consett Garesfield	20 6
Newcastle gas coke ..	12 0 to 12 6

Cardiff.

	s. d.	s. d.
Special foundry coke ..	25 0	to 27 0
Foundry coke	20 0	to 23 0
Furnace coke	17 0	to 19 0

Leeds.

Furnace coke..	10 9 at ovens.

Birmingham.

		s. d.	s. d.
Foundry coke		31 0	to 37 6
Furnace ,, ...		14 0	to 17 6
Gas ,, ...		14 0	to 15 0

Glasgow.

Foundry coke	—	to 27 0
Furnace ,, ...	—	to 18 0
Gas ,, ...	—	10 6

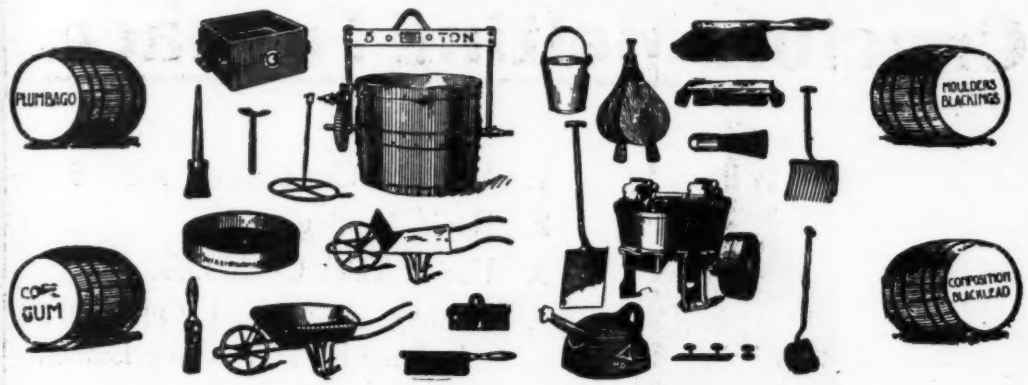
London.

Foundry coke	27 0	to 28 0
Gas	16 8	to 18 4

Established 1863.

JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



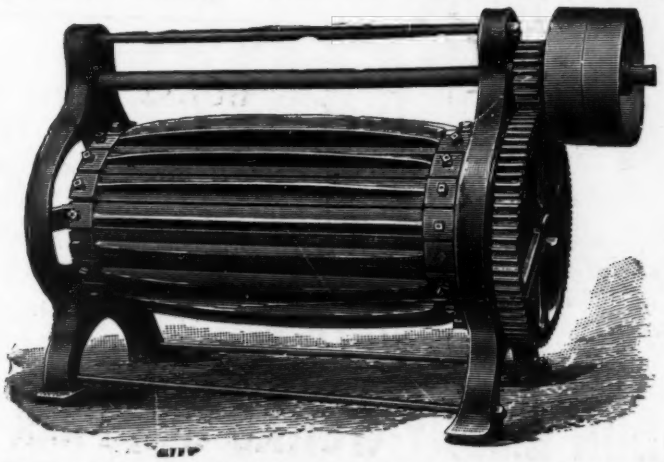
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

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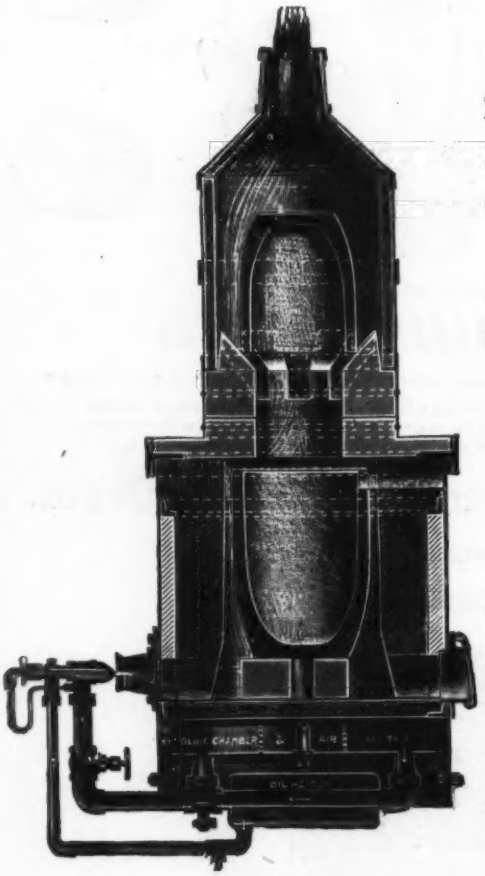

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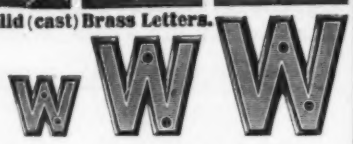

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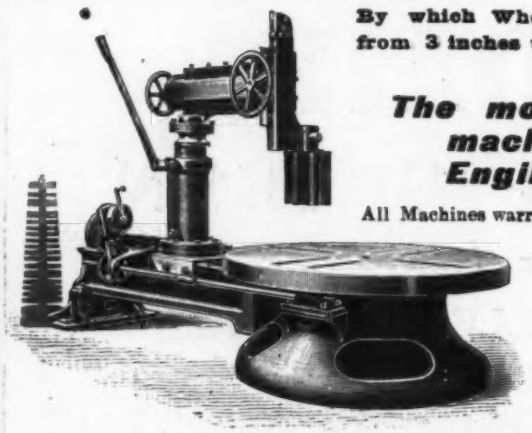

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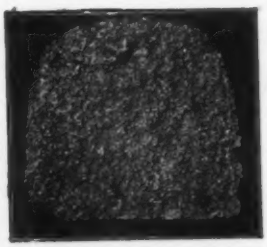
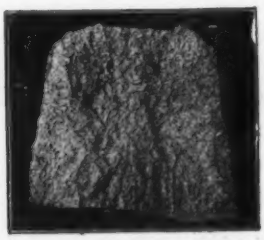

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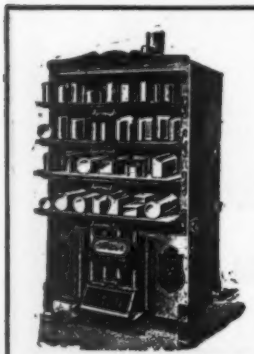

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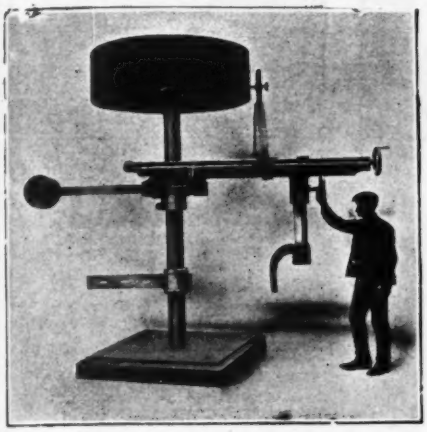

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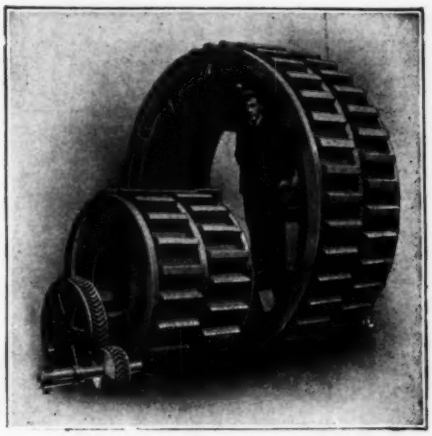

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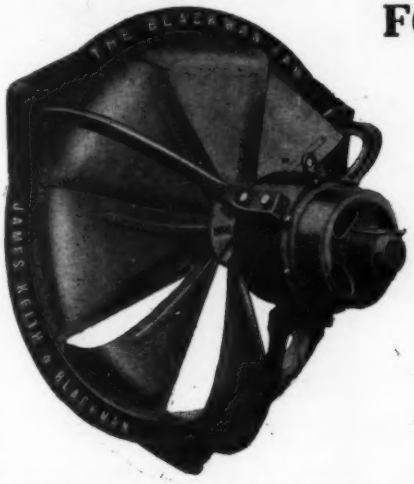

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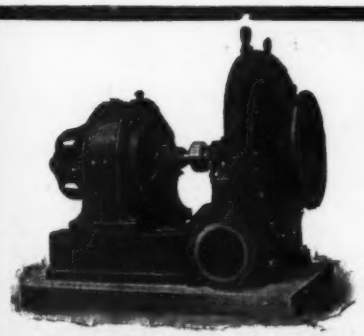

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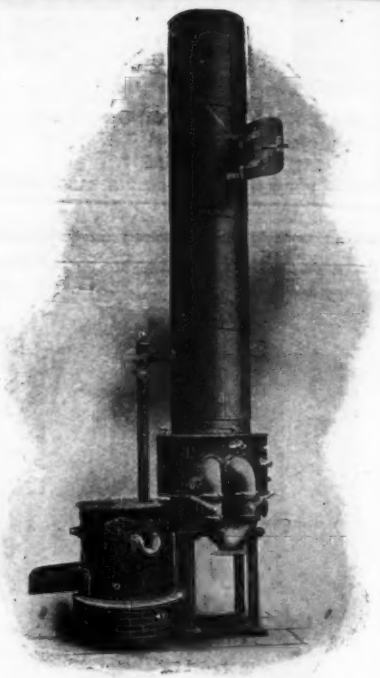

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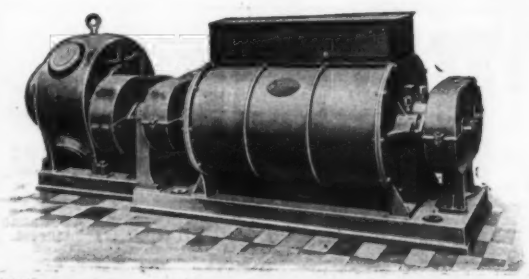

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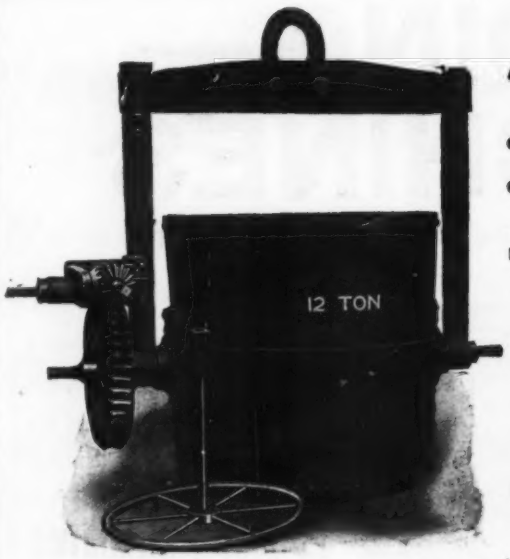

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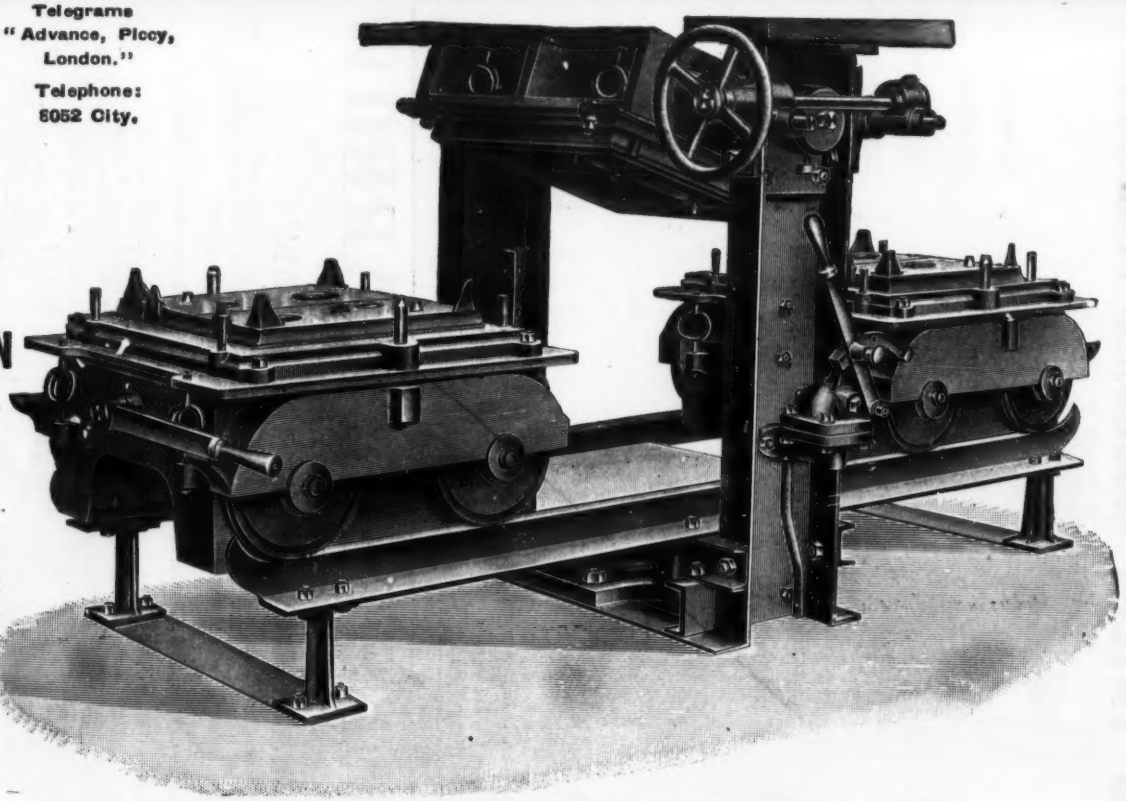

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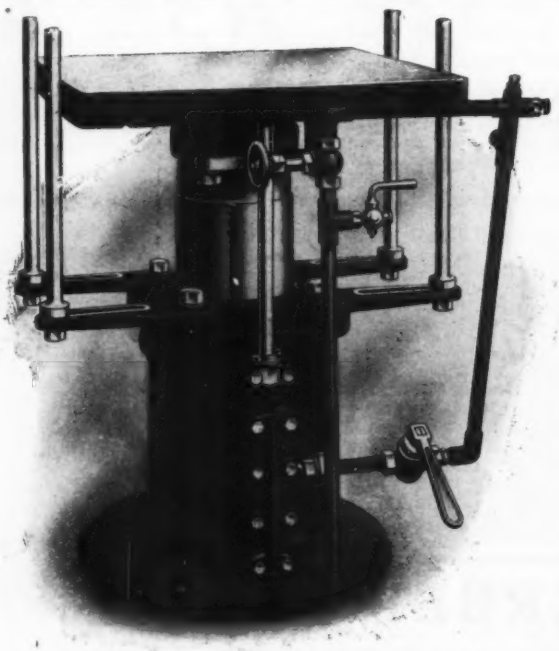

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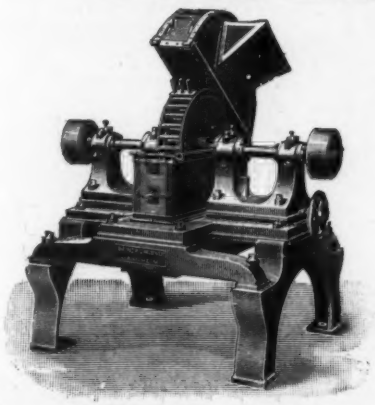

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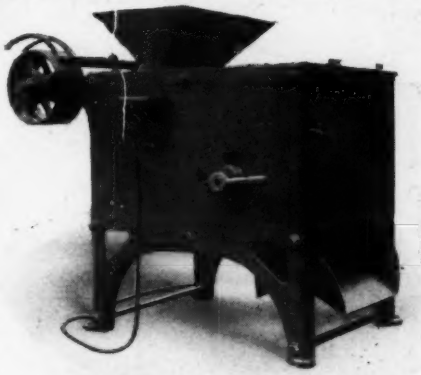

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